INTERFACES 4

New Prairie Press

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INTERFACES 4

Designing Atmospheres: Theory and Science

Elisabetta Canepa

Investigating Atmosphere in Architecture: An Overview of Phenomenological and Neuroscientific Methods

Abstract
Based on the multi-component character of our emotions, we can study the affective dimension of architectural atmospheres through several approaches. This essay reviews the main research models that employ a first-person perspective (self-observation) and a third-person perspective (external observation), analyzing methodological potentials and limitations. We need a multi-perspective approach to investigate the complexity of the atmospheric vocation of architecture, integrating both models and working on complementary notions: atmosphere and architecture, resonance and attunement, impressions and appraisals, nonconscious and conscious, emotions and feelings, living body and lived body, neuroscience and phenomenology, physiological measures and self-report techniques.

Keywords
architecture
atmosphere
attunement
resonance
feeling
emotion
lived body
living body
conscious
nonconscious
first-person perspective
third-person perspective
phenomenology
neuroscience

F1 Paolo Monti
photo series *Bitonto*, 1970
BEIC 6332714
fragment

1 Jens Soentgen, a German philosopher and chemist, was the first to introduce the idea of an *atmospheric turn* (Griffero 2014; Gandy 2017). At the end of the twentieth century (1998), he noticed a novel aesthetic-experiential emergence centered on affective atmospheres, rising from the theses of new phenomenology (Griffero 2021, chapter I). This animated other disciplines towards an emotional reading of reality including cultural geography (Bille and Simonsen 2021), anthropology (Bille, Bjerregaard, and Sørensen 2015; Asu Schroer and Schmitt 2018), consumer science (Turley and Milliman 2000), tourism research (Volgger and Pfister 2020), architecture and urban studies (Wigley 1998; Havik, Teerds, and Tielens 2013; Borch 2014; Pallasmaa 2014; Tidwell 2014; Leatherbarrow 2015; Pérez-Gómez 2016; Weidinger 2018; Bille

Architecture and Atmosphere

Space, especially built space as "the basis for life and culture" (Frampton 1995, 27), is never neutral. It is charged with *affective affordances* (namely ecological qualities offering a possibility for emotional resonance) that sway the experience of perceiving subjects immersed in that space (Griffero 2020a). The emotional "potential in place" affecting people is what we call *atmosphere* (Duff 2010, 891) — "the life of a place" (Schönhammer 2018, 141).

"Atmosphere is the prototypical 'between'-phenomenon," wrote the German philosopher Gernot Böhme (1998, 112) at the beginning of what is now known as the "atmospheric turn." [1] Atmospheres are phenomena experienced "in the intersection of the objective and the subjective" (Edensor and Sumartojo 2015, 251): they are *co-constituted* by both the materiality of our surroundings and corporeality of our bodies (Canepa 2022a). The most challenging aspect is that "an atmosphere is at once a condition and is itself conditioned" (Anderson and Ash 2015, 35). We know atmospheres are spatial phenomena, but we are equally aware atmospheres cannot exist without the presence of a body that perceives them (Canepa 2022b). Only in this way does architecture come alive and become *atmosphere* — space that lives: ineffable space [2] [**F1**].

Visible and invisible

The phenomenology of atmospheres identifies a series of lived qualities making atmosphere extremely difficult (if not impossible) to describe (Canepa 2022a, chapter I). In the first place, atmosphere is *invisible*. Atmosphere is then *incorporeal* which is different from being invisible and still more indefinable on a perceptual level. Atmosphere cannot be touched, isolated, or attributed to a specific concrete source. Air is also

and Sørensen 2019; Griffero 2019; Sumartojo and Pink 2019; Condia 2020; Canepa 2022a; Canepa and Condia 2022). As professor Harry Francis Mallgrave recalls in the next few pages, we must acknowledge, "although the neologism 'atmosphere' dates from only the seventeenth century, the idea of a building's emotional resonance has always been central to architectural practice" (2023, abstract).

2 The atmospheric aura pervades our surroundings and touches our bodies in a synaesthetic and integrated manner. It causes the "play of masses" to lose clarity and transform into "ineffable space": "then a boundless depth opens up, effaces the walls, drives away contingent presences, *accomplishes the miracle of ineffable space* [...] the consummation of plastic emotion" (Le Corbusier 1948, 8: original italics).

invisible. However, air has its own sensorially perceptible consistency, caused by the pressures it exercises on our skin, alternating temperatures, and smells with which it carries. Air leaves traces of its presence on the material elements it brushes, blowing up curtains, making glass vibrate, and swirling dust [**F2**].

Since atmosphere is everchanging and without tangible boundaries, it is unthinkable to precisely locate or physically contain it. "Like clouds in the sky," atmospheres "are ever forming and reforming, appearing and disappearing, never finished or at rest" (Asu Schroer and Schmitt 2018, 1). Atmosphere is like the sea: *difficult*.

> Plasson [the artist]: The *sea* is difficult.
>
> Bartleboom [the scientist]: ...
>
> Plasson: It's difficult to know where to begin. You see, when I used to do portraits, portraits of people, I used to know where to begin, I would look at those faces and I knew exactly (stop)
>
> Bartleboom: ...
>
> Plasson: ...
>
> Bartleboom: ...
>
> Plasson: ...
>
> Bartleboom: You used to paint people's portraits?
>
> Plasson: Yes. [...] When I painted people's portraits, I used to begin with the eyes. I would forget all the rest and concentrate on the eyes, I would study them, for minutes and minutes, then I sketched them in, with a pencil, and that was the secret, because once you have drawn the eyes (stop)
>
> Bartleboom: ...
>
> Plasson: ...
>
> Bartleboom: What happens once you have drawn the eyes?

F2 Paolo Monti
photo series *Cervia*, 1974
BEIC 6339209

Plasson: It happens that all the rest just follows, it's as if all the other pieces slip into place around that initial point by themselves, there's not even any need to (stop)

Bartleboom: ... There's not even any need.

Plasson: No. One can almost avoid looking at the sitter, everything comes by itself, the mouth, the curve of the neck, even the hands ... But the fundamental thing is to start from the eyes, do you see, and this is where the real problem lies, the problem that drives me mad, lies exactly here (stop)

Bartleboom: ...

Plasson: ...

Bartleboom: Do you have an idea where the problem lies, Plasson?

[...]

Plasson: The problem is, *where the dickens are the eyes of the sea?* I shall never get anything done until I find out, because that is the *beginning*, do you see? The beginning of everything, and until I know where they are, I shall carry on spending my days looking at this damned stretch of water without (stop)

Bartleboom: ...

Plasson: ...

Bartleboom: ...

Plasson: This is the problem, Bartleboom ...

Magic: this time he got started again on his own.

Plasson: This is the problem: *Where does the sea begin?*

Bartleboom said nothing.

The sun came and went, between one cloud and the next. It was the north wind, as usual, which organized the silent spectacle. The sea carried on imperturbably reciting its psalms. If it had eyes, it was not looking in that direction at that moment.

Silence. Minutes of silence.

Then Plasson turned to Bartleboom and said, all in one breath, "And you, sir, what are you studying with all those funny instruments of yours?"

Bartleboom smiled.

"Where the sea *ends*."

Two pieces of a puzzle. Made for each other.

[...]

This time there are two people seated on Bartleboom's windowsill. The usual little boy. And Bartleboom. Their legs dangling over the emptiness below. Their gaze dangling over the sea.

"Listen, Dood ..."

The little boy's name was Dood.

"Given that you are always here ..."

"Mmmmh ..."

"Perhaps you know."

"What?"

"Where does the sea have its eyes?"

"..."

"Because it does have them, doesn't it?"

"Yes."

"And where the dickens are they?"

"The ships."

"The ships *what*?"

"The ships are the eyes of the sea."

Bartleboom was flabbergasted. He really had not thought of that.

"But there are hundreds of ships ..."

"The sea has hundreds of eyes. You can hardly expect it to get things done with only two ..."

F3 Paolo Monti
photo series *Monterosso al Mare*, 1960
BEIC 6364393
fragment

> Quite. With all the work it has to do. And as big as it is. There is good sense in all this.
>
> "Yes, but then, excuse me ..."
>
> "Mmmmh."
>
> "And people who are shipwrecked? The storms, the typhoons, all that stuff there ... Why ever should it swallow all those ships, if they are its eyes?"
>
> Dood looks almost a little out of patience, when he turns toward Bartleboom and says, "But you, ... don't ever close your eyes?"
>
> Christ. He has an answer for everything, this boy.
>
> He thinks, does Bartleboom. He thinks and mulls things over and reflects and reasons. Then he suddenly jumps down from the windowsill. Toward the room, of course. You would need wings to jump down in the other direction.
>
> "Plasson ... I must find Plasson ... I have to tell him ... blast, it wasn't so difficult, all you had to do was think about it a little ..."
>
> He searches feverishly for his woolen hat. He does not find it. Wholly understandable: it is on his head. He desists. He runs out of the room.
>
> "See you later, Dood."
>
> "See you later."
>
> The boy remains there, with his eyes fixed on the sea. He stays there for a little. Then he takes a good look to see that no one is around and suddenly jumps down from the windowsill. Toward the beach, of course.

The *sea's eyes metaphor* (Baricco 1999, 82–84; 90–92: original italics) [**F3**] is helpful in introducing the complexity of something so elusive and ineffable as what we atmospherically feel (or have felt) — or even intended to experience. A tension emerges, and progressively grows, between the apparent non-rationality of the atmospheric phenomenon and our determination to comprehend, represent, and design it (Rauh 2018). On the one hand, architects (and others) show an increasing interest in studying atmospheres (Stec 2020; Canepa 2022a), searching for

F4 Paolo Monti
photo series *Monterosso al Mare*, 1957
BEIC 6329237

the meaning of sensations outside the visual that enliven the body of architecture. On the other hand, the ephemeral and immaterial qualities of our surroundings hold resistance to the traditional methods of analysis and discussion of spatial experiences. They require a more subjective approach, holistic as it were, interconnected with sensory, emotional, and cognitive capacities of the perceiver [**F4**].

The more elusive anything is that we have experienced and wish to recount (as in the case of the atmosphere of a place), the more precise we must be in articulating and communicating its effects on us. Just think of how many lines poets and novelists have dedicated to the sea. One possible strategy to capture the profound essence of a place is the "extension of human identity into our environment" (Bloomer and Moore 1977, 131) through one's lived experiences, memories, bodies, and their points of reference (Havik 2019). We need to search for the *atmosphere's eyes*, the initial clue that allows us to understand and answer crucial questions like the following [**F5**]:

where is atmosphere located?
where does atmosphere begin?
where does atmosphere end?
what difference does atmosphere trigger in a place or a situation?

Lived Body and Living Body

One of the few key points scholars of atmospheric dynamics in various disciplines agree on is that "there is no such thing as an unfelt atmosphere" (Osler and Szanto 2022, 183 n. 1). By the term "body," we refer to the holistic complexity of our corporeality: the biological or-

F5 Paolo Monti
photo series *Venezia*, 1960
BEIC 6342454

ganism (the *living body*, anatomical infrastructure responsive to sensory impressions afforded by the context) is completed by life experiences unique to each individual (as metabolized by the *lived body*, which allows the subject to grasp the personal nature of the received stimuli). [3] We both *have* living bodies and *are* lived bodies (Shusterman 2006, 3). "There are not *two* things that need to be integrated here, but one body, physiological and lived," as the philosopher Shaun Gallagher explains (1986, 140: original italics). The distinction between living and lived is a perceptual distinction: we undergo a physiological change, *and* our body may feel that change.

From a methodological perspective, the study of atmospheres has been and is largely dominated by a phenomenological approach, grounded on accounts of the lived body — the body experienced by the perceiving subject from a *first-person perspective*. [4] In recent years, fields surrounding atmospheric research have increasingly emphasized the living body, observable through a *third-person perspective* and supported by breakthroughs and theoretical advancements in empirical sciences like neuroscience, [5] among others (Mallgrave and Gepshtein 2021). They can shed new light on the lived body "by investigating" the living body (Gallese and Cuccio 2015, 19) of which the brain and the autonomic nervous system are constituent parts. Since atmospheres affect us on nonconscious, preconscious, and conscious levels, [6] we must study the *living-lived body* loop. This unity embeds the overall relationship between physiology and experience, jointly requiring an experimental and phenomenological analysis as envisaged by the *enactive approach* (Jelić et al. 2016). [7]

Examining the biological roots of the atmospheric event is a step complementary and not exclusive to comprehending the complexity of its

3 For what we narrowly refer to as "body" in English, German offers two words with quite distinct meanings: *Körper* and *Leib*. The American philosopher Richard Shusterman suggests, "*Körper* denotes the physical body as object, while *Leib* typically signifies the lived, feeling body or the body as intentionality or subject" (2010, 207).

4 For an accurate "atmospheric bibliography," see the authoritative work promoted by Atmospheric Spaces, an international community researching the phenomenological-aesthetic dimension of atmospheric experience coordinated by the Italian philosopher Tonino Griffero. Their literature review is online (www.atmosphericspaces.wordpress.com). It is an ongoing project constantly updated, which takes the conventional start date of 1968 — the year in which the German psychiatrist Hubertus

Tellenbach published his first book dedicated to the concept of atmosphere: *Geschmack und Atmosphäre* (meaning in English, "Taste and Atmosphere"). Alongside, visit the bibliographical repository developed by the EU-funded RESONANCES project for a more architectural viewpoint (www.resonances-project.com/lit).

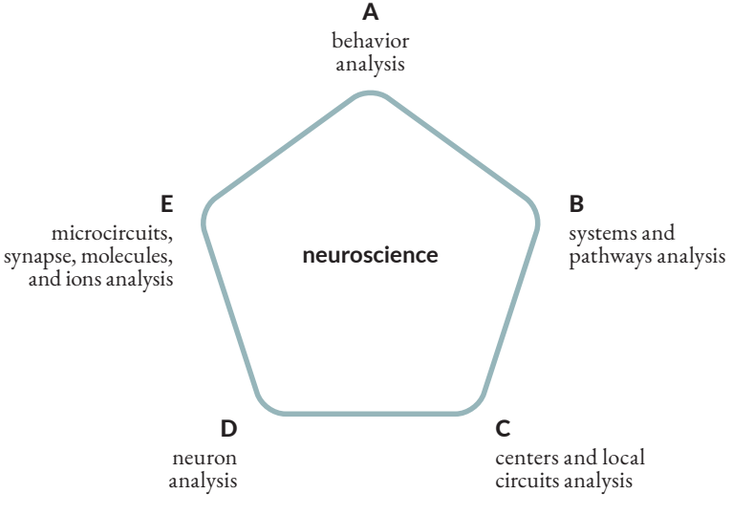
5 *Neuroscience* is an interdisciplinary domain that empirically studies human experience based on the brain or, more generally, the nervous system activity [**F6**]. Enlarging the field of focus, neuroscience resolves "to understand the biological underpinnings of our emotional life" (Albright et al. 2000, s1).

6 The neuroscientists Marco Tamietto and Beatrice de Gelder (2010) propose a focus to face the "terminological jungle" present when discussing *consciousness*. They differentiate several terms to describe perception without awareness, including "unconscious," "nonconscious," "subliminal," "implicit," "automatic," and "pre-attentive." In particular, we learn the distinction between "unconscious" and "nonconscious." "The first term is rooted in the psychoanalytical tradition and postulates the existence of an active mechanism of psychodynamic suppression of conscious information. By contrast, the use of 'nonconscious' is rooted in the experimental psychology tradition and indicates a perceptual state in which the subject does not report the presence of a stimulus or of one of its attributes (for example, its emotional content) even though there is evidence (behavioral, psychophysiological, or neurophysiological) that the stimulus has in fact been processed" (Tamietto and de Gelder, 698). In this essay, we adopt the "nonconscious" form, as suggested by the authors. See also Djebbara 2023.

7 See the theory of the *feeling body* (Colombetti 2017) for further details on how to apply the enactive method developed in cognitive science and philosophy of mind to affective dynamics.

F6 How neuroscience is structured: levels of organization and levels of explanation in the nervous system (adapted from Bermúdez 2020, 8)

A behavioral neuroscience
B cognitive neuroscience
C systems neuroscience
D cellular neuroscience
E molecular neuroscience



8 See the methodological review and the case study presented in upcoming sections.

9 Cf. De Matteis et al. 2019 (§ 40–42), where the authors discuss a "non-coincidence between perception and affective involvement."

experiential essence. One crucial question is how we can link a growing understanding and systematization of architectural atmospheres (Canepa 2022a) to the study of the brain, body, and their emotion-related mechanisms (Arbib 2021). Distilling a definition informed by interdisciplinary criteria, atmosphere turns into a describable and even potentially measurable entity — empirically accessible with experimental protocols aimed to detect our emotional responses to architectural contexts. [8]

Resonance and Attunement

We decipher the atmospheric experience as a *state of emotional resonance and attunement between the perceiving subject and their architectonically arranged surroundings*. Involvement in the co-production of an atmospheric event implies being emotionally affected by it without requiring complete alignment with it. Individuals may feel in tune with a specific atmosphere but also disregard or reject it. "Saying," for instance, "we bodily grasp the happiness of the party as an atmosphere is not to suggest that we must feel happy ourselves" (Osler and Szanto 2022, 166); moreover, we need to consider the possibility that "we might even get the atmosphere wrong" (Osler and Szanto, 167). There is, hence, a crucial distinction between perceiving the presence of an atmosphere (*resonance*) and being affectively involved in it (*attunement*). [9]

Resonance unfolds our innate predisposition to be touched by the external world. It results from the instantaneous arousal of the *first impressions* that shape our spatial experiences by interacting with the affective affordances embedded in the environment (Griffero 2020b). "We perceive atmosphere through our emotional sensibility — a form of percep-

10 Theoretical models of emotions are "as old as psychology itself, or even older" and "many different attempts at conceptualizing and measuring emotions have been made" (Küller et al. 2006, 1504). Although we have studied emotional dynamics for a long time, there are no univocal definitions. A review published in the early 1980s identifies more than ninety meanings in emotion literature (Kleinginna and Kleinginna 1981). The operational definitions presented here are beneficial for the multi-perspective approach we suggest and are currently under investigation at the P\Lab2003, directed by Professor Bob Condia and hosted in the Architecture Department of Kansas State University.

11 Aside from more differentiation, emotions are fundamentally significant or irrelevant (*arousal* component) and positive or negative (*valence* component). For further explanation of affective arousal and valence, see n. 17.

12 From an embodied perspective, resonance can trigger and prime the subject's attunement *if* the atmospheric event is particularly relevant to them.

13 See the *atmospheric equation* analyzed in Canepa 2022b.

14 Cf. Bower, Tucker, and Enticott 2019. Their systematic review found only seven projects that coupled self-assessment procedures with measures of autonomic and/or central nervous system activity to understand how the design of interior settings influences human emotions. This result means, while we intuitively believe our architectural surroundings play a crucial role in generating and experiencing atmospheres, we must still consolidate evidence of the emotion-related (neuro)physiolog-

tion that works incredibly quickly, and which we humans evidently need to help us survive," as Peter Zumthor (2006, 13) teaches us in one of the most quoted excerpts about atmospheric perception. First impressions are profound and beneficial events as they provide us with meaningful information from complex scenes, whether static or in motion, with just a glance, without needing to scrutinize every detail. Research shows first impressions occur at extreme speed, a fact highly praised by architects, proving essential for our interaction with the physical world (Bar, Neta, and Linz 2006; Djebbara et al. 2019). There are four basic modalities through which first impressions arise and manifest: [10]

A *emotions*
internal somatic feedback, nonconsciously developed, even if consciously recognizable;

B *expressions*
outwardly physiological and proprioceptive feedback, mostly nonconscious;

C *action tendencies*
behavioral feedback, mainly nonconscious;

D *feelings*
cognitive feedback of the emotional experience as consciously felt.

Emotions, expressions, and actions are the bodily correlates of feelings, mutually interacting and affecting. For example, we may sense our heart pounding [**A**], our face flushing with eyebrows twitching [**B**], or an urge to leave the room [**C**], *and* consciously feel nervous [**D**]. Through the resonance process, that is, through our bodily reactions [**A**, **B**, **C**] and — or without — the conscious experience of the felt emotional state [**D**], we perceive the presence of a particular atmosphere. If asked or externally observed, individuals show that *they* feel (or felt) excited or impassive, happy or sad. [11] The perceiving subjects are the focus. *We* are the focus.

Attunement is the potential [12] conscious act of appraising an atmospheric experience in which we evaluate its affective content relating the external world to our subjective perception of it. Through the attunement process, that is, through our *affective appraisals*, we assign to our surroundings a meaning grounded on that which resonance gives us, modulating our affective engagement and attachment with that atmosphere. Affective appraisals occur when the perceiver attributes affect-based qualities to the place-elicited stimuli, such as positive or negative, significant or irrelevant. If asked, individuals reply that *the place's atmosphere* is (or was) exciting or calm, pleasant or unpleasant. The target is the external world, filtered through our sensibility and colored by current moods, motivations, concerns, and expectations. [13]

Using a neuroscientific approach, supported by other branches of knowledge (such as psychology and phenomenology), we can evaluate — performing *in vivo* experiments — any correlations between nonconscious body/brain activation and the conscious perception of emotions towards a space. [14] In other words, *resonance* — involving both nonconscious sensations and conscious feelings — is the segment of the atmospheric experience we can assess by adopting a *multi-perspective* methodology.

Recognizing the multi-component nature of our emotional responses (conscious and nonconscious: feelings and emotions) allows us to in-

ical effects. More updated review papers confirm the same small number of research adopting an effective multi-perspective paradigm (Kim and Kim 2022).

15 *Interoceptive sensitivity* is our ability to perceive visceral information from the body (such as heartbeat, respiration, gastroesophageal sensations, itching, and pain) and interpret related physiological changes. Interoception influences our capacities to recognize and experience emotions (Barrett et al. 2004; Zamariola et al. 2019). The hypothesis is that people who are more interoceptively sensitive (that is, more attuned to their internal body signals) are more accurate in perceiving and understanding their surroundings (Murphy Paul 2021). So far, however, it has not been confirmed whether our inside body perspective influences how we perceive the outside world (Baiano et al. 2021).

vestigate the *affective dimension of architectural atmospheres* through several approaches. The preliminary, essential distinction identifies two assessment perspectives:

a *first-person perspective* (self-observation) and
a *third-person perspective* (external observation).

First-Person-Perspective-Based Research Models

In first-person observation, focus is on analyzing consciously perceived emotional states. This approach reconstructs a picture of *what* we are currently feeling (or have previously felt) in the first person. Such an account is necessary since "every subjective phenomenon is essentially connected with a single point of view" (Nagel 1974, 437). Descriptions of phenomenological content (grounded on lived experiences) "need not convey an experience of emotion in all its richness and complexity to have scientific utility and value" (Barrett et al. 2007, 375). We can metabolize, assimilate, and express our spatial experiences in a plurality of modalities (De Matteis et al. 2019). Articulating experience implies "providing a means to put words to bodily sensations" (Höök 2018, 107). We can accomplish that in three moments:

in *real-time* practicing bodily interoception [15]
and emotional introspection; [16]

after the experience has occurred;

or *before*, in order to compare the beginning status
with the altered one.

16 A rough definition of *introspection* alludes to the process through which we direct our attention inward to analyze emotional experiences as consciously felt.

17 We traditionally distinguish three components as capable of subserving all affective states (cf. the circumplex model of affect): *arousal* scores the intensity of our emotional experience, that is, how strong it is; *valence* assesses the pleasantness of our emotional experience, that is, how positive it is; and *dominance* correlates with feelings of control and how much someone feels constrained in their emotional experience. Many techniques detect these three factors; most common are Likert-type scales and self-assessment manikins. Likert-type scales are rating systems, measuring perceptions as a spectrum ranging from one extreme value to another (e.g., from "not at all" to

Multiple strategies have been developed and improved over time:

verbal self-report systems, employing written accounts (e.g., questionnaires, surveys, notes, and diary entries) or oral accounts (e.g., discussions, interviews, and audio/video recordings);

nonverbal self-report measures, which can be graphical methods (e.g., Likert-type scales and the more picture-oriented SAM: Self-Assessment Manikin) [17] or go beyond the purely visual format (e.g., PONS: Profile of Nonverbal Sensitivity, designed to decode bodily, facial, and vocal clues);

visualization tools, based on 2D techniques (e.g., drawings, body maps, and photographs) or 3D techniques (e.g., mockups and molding soft clay), which offer creative ways of processing experience;

and, lastly, there is a growing interest in *storytelling* procedures, where adopting paradigms inspired by literature methods (i.e., stories), it is possible to balance reality and imagination (Pericoli 2022).

First-person-perspective-based research models present intrinsic methodological limitations:

people can control and manipulate their evaluations in self-report ratings, conditioned by cognitive biases (such as preconceptions, warries, performance expectations, or learning effects);

introspection is a complex process, even if we tend to presume individuals are always able to understand and articulate what they feel

"extremely"). A Likert-type scale may have a varying length, a discrete set of items (coded numerically and/or verbally), or a continuous interval. The Self-Assessment Manikin (SAM) is a graphical upgrade of the Likert-type scales employed to rate valence, arousal, and dominance associated with a person's affective reaction to a given stimulus (Bradley and Lang 1994).

18 We should also consider people "differ considerably in their emotion experience" (Barrett et al. 2001, 713). The psychologist Lisa F. Barrett coined the expression *emotional granularity* to explain our ability to discriminate the specificity of felt emotions. A high emotional granularity affords fine-grained distinctions between similar emotions (namely, emotions with similar levels of valence and arousal, cf. n. 17) and describe their experiences with discrete emotional labels. Conversely, a limited emotional granularity flattens the landscape of our feelings, reducing the number and the reliability of our introspection feedback.

19 The spectrum of emotional reactions is highly fleeting and variable: on the one hand, we are all genetically unique and constantly shaped by the affordances embedded in our surroundings; and on the other, we are always different from ourselves, affected by transient factors, of environmental or personal origin (cf. Canepa 2022b).

20 Cf. the remark with which Zakaria Djebbara opens his essay in this book: despite the Interfaces 2023 symposium called *Designing Atmospheres: Theory and Science*, "the theory and the science of atmosphere are largely unbalanced, in favor of the theory" (2023, 75).

21 The neuroscientific study of emotion

or have felt (sometimes they expressly do not want to divulge their impressions); [18]

the presence of the listener (who can be a friend as well as a stranger like a scientist) interferes in the external disclosing the own internal state;

and generalizability and transferability are restricted. [19]

Despite these main limitations, self-observation methods have been extensively validated through testing, are user-friendly, and are reasonably inexpensive. Most importantly, first-person phenomenological translations of our atmospherical experiences are crucial because — in the end — only those who experience the emotional resonance can articulate it.

Third-Person-Perspective-Based Research Models

"There is now increasing evidence that nonconsciously perceived emotional stimuli induce distinct neurophysiological changes and influence behavior towards the consciously perceived world" (Tamietto and de Gelder 2010, 697). Notwithstanding that "architecture is an act of conscious willpower" (Le Corbusier 2015 [1930], 68), it is rarely at the forefront of our attention on a daily basis (Peri Bader 2015). As emphasized by Frank Lloyd Wright, architecture is the "background or framework" of our existence (1992 [1908], 95). "People usually do not focus on architectural features but rather live the space in a habitual and automatic manner" (Vecchiato et al. 2015, 15). Two premises are essential:

nonconscious (or at least marginally conscious) perception of emotional affordances is the predominant way to experience our built surroundings;

emotions contribute to processing environmental stimuli, driving behavior and decision-making even without explicit access to our autonomic and somatic responsivity.

Supported by these assumptions, *atmosphere* — particularly the resonance stage — becomes the primary constituent of our spatial experiences. Examining the role of bodily, nonconscious sensations in atmospheric dynamics is still an open scientific question, crucial in understanding how we experience designed environments. [20]

While first-person observations are limited to consciously perceived emotional states (namely feeling), third-person observations evaluate nonconscious and preconscious emotions on three different levels: [21]

on the *experience level*, studying behavioral outputs (action tendencies or interferences on task performance) and corporeal expressions;

on the *body level*, recording physiological activities;

and on the *brain level*, monitoring neural functioning.

In numerous academic disciplines such as applied marketing research and consumer science (Bell et al. 2018), attempts have been made to move beyond first-person observation and the only use of subjective indicators of psychological factors. Architectural studies began integrating quantification of emotions with biometrics and virtual reality

saw the light at the dawn of the nineteenth century when psychology turned into a scientific discipline distinct from philosophy. For a brief historical reconstruction of the brain basis of emotions, the current state of the art, and a scientific critique of the classical theories of emotion (including basic emotion approaches and causal appraisal approaches), see Barrett and Satpute 2019.

(Bower et al. 2019; Mostafavi 2021; Kim and Kim 2022). Explicit behavior decisions, expressive reactions, and (neuro)physiological measures record those effects that self-report tools cannot identify. Different techniques (Karakas and Yildiz 2020), in constant development especially in terms of resolution and wearability, are available:

action tendencies (experience level): when compared to other markers of emotional responsivity, methods for detecting action tendencies are limited (Delplanque and Sander 2021). They include, for instance, posture measurements, laboratory paradigms to evaluate approach-avoidance motivations, speed monitoring, and tests with sensors based on accelerometer data;

effects on task performance (experience level): from a behavioral perspective, nonconsciously perceived stimuli can interfere with explicit outputs of an ongoing task by, for example, altering reaction time, influencing attention engagement, or modifying perceptual sensitivity;

expressive responses (experience level): continuous emotional signals come from our body via multiple sensory modalities and are noticeable especially through visual clues (e.g., body posture and orientation, facial mimicry, gestural prompts, and involuntary movements), auditory clues (e.g., prosody and vocal acoustics), and their integration. When the key emotional dimension to examine is valence, studying facial expressions is one of the more reliable methods. Two techniques are often used: Facial Expression Analysis (FEA), detected by video captures, and Facial Muscle Activity (FMA), monitored by Electromyography (EMG) electrodes, which record the electrical activity produced by skeletal muscles;

physiological activity (body level): this group refers to the activation of the autonomic section of our peripheral nervous system, articulated into the sympathetic, parasympathetic, and enteric apparatuses. The autonomic nervous system coordinates somatic, emotional, and behavioral responses of an organism regulating its homeostasis, which maintains the essential physiological processes at optimal (or, at least, acceptable) levels. It can give prompt integrated responses to variations in the external environment, acting largely nonconsciously. Examples of physiological markers of emotional correlates are Electrodermal Activity (EDA), Heart Rate (HR), Blood Pressure (BP), Respiration Rate (RR), Skin Temperature (ST), Muscular Potentials (MP), Pupillometry (P), Eye Movements (EM), and Hormonal Secretions (HS);

neural activity (brain level): this last investigation stage explores the emotion-related effects on the central nervous system, specifically brain functioning. Two main inquiry procedures are currently in use: neurophysiology and neuroimaging techniques. Neurophysiology includes Electroencephalography (EEG), which scan the brain's electrical activity, and neuroimaging includes Functional Magnetic Resonance Imaging (fMRI) and Positron Emission Tomography (PET), which measure hemodynamic changes (blood flow).

Multi-Perspective Research Models

Self-reports and (neuro)physiological measures are complementary strategies for gathering data on feelings and emotions, though their results do not always correlate (Bower et al. 2022). They might even seem contradictory when people, for example, claim they felt no emotion, but

22 Adopting the term "marker" is a tribute to the neuroscientist Antonio Damasio and his *somatic-marker hypothesis*. Somatic markers are conscious and nonconscious emotion-triggered bodily feedback. They "probably increase the accuracy and efficiency of the decision process. Their absence reduces them" (Damasio 1994, 173).
23 Cf. n. 14.

24 The MSCA fellow Elisabetta Canepa designed and carried out the first RESONANCES experiment at the Kansas State University P\Lab2003 during the academic year 2022–2023. Her supervisors were Bob Condia (K-State), Andrea Jelić (KU Leuven), and Valter Scelsi (UniGe), assisted by a multidisciplinary team: Kutay Güler — VR and eye-tracking expert (K-State), Luca Andrighetto — psychologist (UniGe), and Irene Schiavetti — biostatistician (UniGe). In outlining the theoretical framework and designing the experimental protocol, several international scholars advised Dr. Canepa, including architects, philosophers, and scientists. The P\Lab2003 team helped in all experimental trials: a huge thanks go to Brittany Coudriet, Yvette Fabela, DJ Plankinton, Amanda Shearhart, Jacob Shreve, and Marvy Whittaker. The K-State APDe-

their nonconscious reflexes show otherwise. To properly detect, qualify, and quantify our resonance (that is, a combination of emotions and feelings), a *multi-perspective approach* is required. "Any conscious event has both neurobiological and phenomenological features". Therefore, "knowing about brain activity [...] alone will not provide a full scientific account of emotion experience" (Barrett et al. 2007, 376). Harmonious insights are needed from both the first and third-person perspectives.

A fundamental methodological question is evaluating which research approaches are more informative than others as *emotional markers* (Delplanque and Sander 2021). We must establish what combination of markers (phenomenological, psychological, behavioral, physiological, and neurophysiological) can best analyze emotional responses and check if exposure to the built environment alters the selected emotional markers. [22] Only then can we assess atmospheric qualities' effect on our emotional states. Eventually, if we intend to incorporate a neuroscientific methodology, we must ascertain if nonconscious bodily and neural correlates of atmospheric emotions are consistent with their conscious accounts. Subjective indicators (Schönhammer 2018) may be an effective *baseline* from which quantitative measurements can be compared and verified.

Although architecture's emotional influence on our lived experiences has been broadly theorized (Goldhagen 2017; Canepa 2022a), we have yet to consolidate empirical evidence interdisciplinarily. [23] This is particularly true if we reflect on the multisensory nature of atmospheric interactions (Pallasmaa 2016): validated experiments are scarce and research methods are disparate (Schreuder et al. 2016; Spence 2020). Separating the idea of resonance from that of attunement helps to find neuroscience-informed strategies for comprehending how architectural atmospheres affect us consciously and nonconsciously.

The atmosphere's eyes

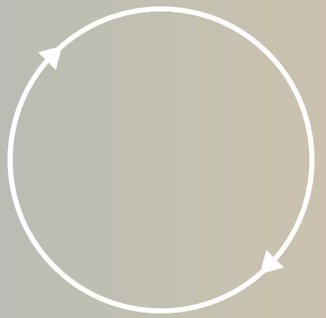
After establishing possible research methods and confirming the importance of integrating first-person accounts with third-person measures, within the EU-funded RESONANCES project, [24] we designed an experimental paradigm to study the affective dimension of architectural atmospheres. Our multi-perspective approach embeds the overarching spectrum of complementary notions analyzed in the previous sections to grasp the complexity of the atmospheric phenomenon [**F7**].

atmosphere —— architecture
resonance —— attunement
impressions —— appraisals
nonconscious —— conscious
emotions —— feelings
living body —— lived body
third-person perspective —— first-person perspective
neuroscience —— phenomenology
(neuro)physiological measures —— self-report assessments

We set out to analyze atmosphere as a *priming condition* for spatial experiences grounded on our definition of the atmospheric dynamic as a state of emotional resonance and possible attunement between the perceiver and their surroundings. Hypothetically, atmosphere *might* prime us to sense, feel, and appraise differently. Priming "reveals the powerful ways in which our past experiences can influence our present and future

Atmosphere

resonance
impressions
nonconscious
emotions
living body
third-person perspective
neuroscience
(neuro)physiological measures



attunement
appraisals
conscious
feelings
lived body
first-person perspective
phenomenology
self-report assessments

Architecture

sign College supported this research project by giving access to the lab facilities.

25 Or *affective priming*, also called *affect priming*.

26 I decided to concisely describe our experiment here. What matters is illustrating how to apply a multi-perspective research model, moving from first-person insights to third-person measures, from phenomenology to biology, and back again.

27 For further discussion about atmospheric generators see Canepa 2022b.

behavior" and contributes to "perception, memory, decision making, and action" (Doyen et al. 2014, 13). Working on affective atmospheres, the notion of *emotional priming* [25] is vital. Its effects depend on the degree of involved consciousness (Lohse and Overgaard 2019); we may even suppose nonconscious perception sways our emotional experience of the subsequent event, situation, or space.

The priming potential of atmospheres is a deep-rooted intuition among architects. Le Corbusier, for example, grasped it very well when describing the transition between outside and inside:

> In Broussa in Asia Minor, at the Green Mosque, you enter by a little doorway of normal human height; a quite small vestibule produces in you the necessary change of scale so that you may appreciate, as against the dimensions of the street and the spot you come from, the dimensions with which [the interior space] is intended to impress you. Then you can feel the noble size of the Mosque and your eyes can take its measure. (Le Corbusier 1931, 167)

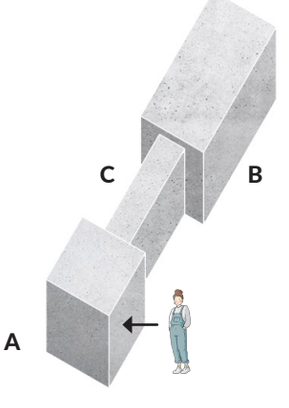
The feeling of airiness and confusion coming from the urban context leaves a residual emotion in the next space, the vestibule, which — in turn — emotionally prepares the following experience, contrasting its intimate atmosphere to the grandeur of the central hall, "a great white marble space filled with light" (1931, 168).

We hypothesize priming effects in architecture occur when our embodied engagement with atmospheric affordances prepares and influences a subsequent, related experience, mainly without our awareness of the priming factor — as with sound in movies. To verify this idea, we analyzed a series of corridors with altered light quality (via luminosity and color), assuming light is a primary *generator of atmosphere*. [26] In a pre-

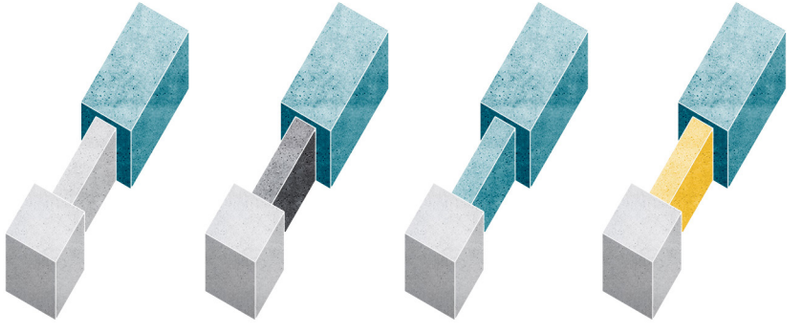
F8 RESONANCES
experiment:
layout diagram

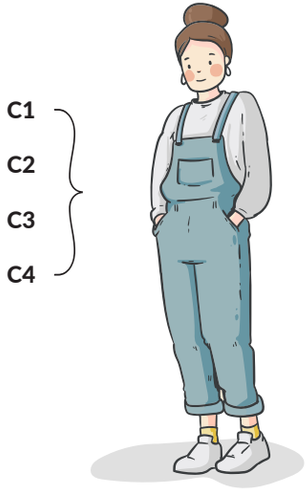
vious study (Canepa et al. 2019), twenty different configurations were assessed. Light manipulation emerged as the most arousing generator of atmosphere, [27] without showing a significant correlation in test subjects' dispositional empathy. This response to light could be because it has strong sensuous power and a broad spectrum of action, affecting our perception regardless of empathic disposition to emotional resonance.

Each experimental session was composed of four corridor iterations, randomly presented and freely explorable in virtual reality. All iterations had the same layout: a corridor connecting two rooms [**F8**]. Participants entered the starting room [**A**] and performed a relaxation exercise to collect baseline data; then they opened the first door and walked along a 5-meter corridor [**C**], following a natural pace. Through the second door, participants accessed the final room [**B**], where they browsed an art installation before replying to a questionnaire (virtually simulated). After answering the queries, they returned to the point of departure [**A**].



F9 RESONANCES
experiment:
corridor variations





28 Before running the experiment, test subjects completed three questionnaires to profile their *emotional intelligence*, *personality*, and *empathic sensibility*. Cf. n. 18.
29 Electrodermal activity (EDA) is a continuous process generated by imperceptible and involuntary changes in the electrical behavior of the skin, which serves as our interface with the physical world. EDA is a sensitive marker of humans' sympathetic autonomic nervous system activity by measuring sweat gland function. As sweat glands are more active, due to physiologic or emotional stimulation, the electrical conductance of the skin increases, given that sweat conducts electricity (Subramanian et al. 2021). EDA provides data on the amount of sweat secretion, making it a strong indicator of emotional arousal. Its increases vary directly with self-report-

The starting and ending rooms remained constant, whereas the light in each corridor varied in brightness and color. We examined four variations [**F9**]: a bright corridor (**C1**: in continuity with the first room), a dark corridor (**C2**: as opposed to the first room), a blue corridor (**C3**: in continuity with the ending room), and an amber corridor (**C4**: as opposed to the ending room). The aim is to determine *whether* and, if so, *how* different atmospheres prime the emotional experience of the next room, which we assess in terms of resonance and attunement. If we can detect any change in participants' first impressions of the same ending room, this data would indicate the corridor's atmosphere resonated with their sensibility, affecting their emotional engagement and evaluation. We investigated the *resonance* mechanisms foremost through the *living body* then filtered via the lived body; the *attunement* appraisals were analyzed merely through the *lived body*, which contributes to attributing to the surroundings a meaning backed by our nonconscious impressions.

First-person perspective, informed by a phenomenological approach to the architectural lived space, was applied to the *conscious* essence of resonance and attunement, assessing *feelings* through self-reports. As soon as participants entered the final room, they virtually answered six questions.[28] Three items evaluated atmospheric resonance based on the basic dimensions commonly adopted to describe emotional responses:

arousal, scoring the intensity of the felt emotional experience;

valence, grading the pleasantness of the felt emotional experience;

and *dominance*, rating the felt emotional experience's influence.

ed arousal levels, regardless of whether the experience is described as pleasant or unpleasant (Lang et al. 1993). The EDA signal has two components (Amiez and Procyk 2019): the *skin conductance level* (SCL) is a background tonic profile associated with slow alterations elicited by the environment that serves as an individual's mean-value baseline; the *skin conductance responses* (SCRs), on the contrary, are the rapid phasic changes that occur in response to particular eliciting stimuli, generally external. SCR is the component used to detect autonomic arousal variation and is interpretable as a form of individual stimulus-response. The term *electrodermal activity* (EDA) is often associated only with the component of the *skin conductance response* (SCR), also known as *galvanic skin response* (GSR).

Three items sifted through attunement intentions using these cognitive markers:

sense of agency to inspect how much individuals evaluate the emotional experience as under their control;

sense of presence to monitor how much individuals evaluate the emotional experience as engaging;

and *approach-avoidance motivation* to comprehend how much individuals evaluate the emotional experience as attractive and satisfying.

Third-person perspective, supported by a neuroscientific methodology, was applied to the *nonconscious* dimension of resonance, tracking *emotions* through autonomic measures of arousal. Participants wore four electrodes strapped to the fingers of their non-predominant hand. The sensors utilized were non-invasive, portable, and compatible with VR technology. Three physiological markers were combined [**F10**]:

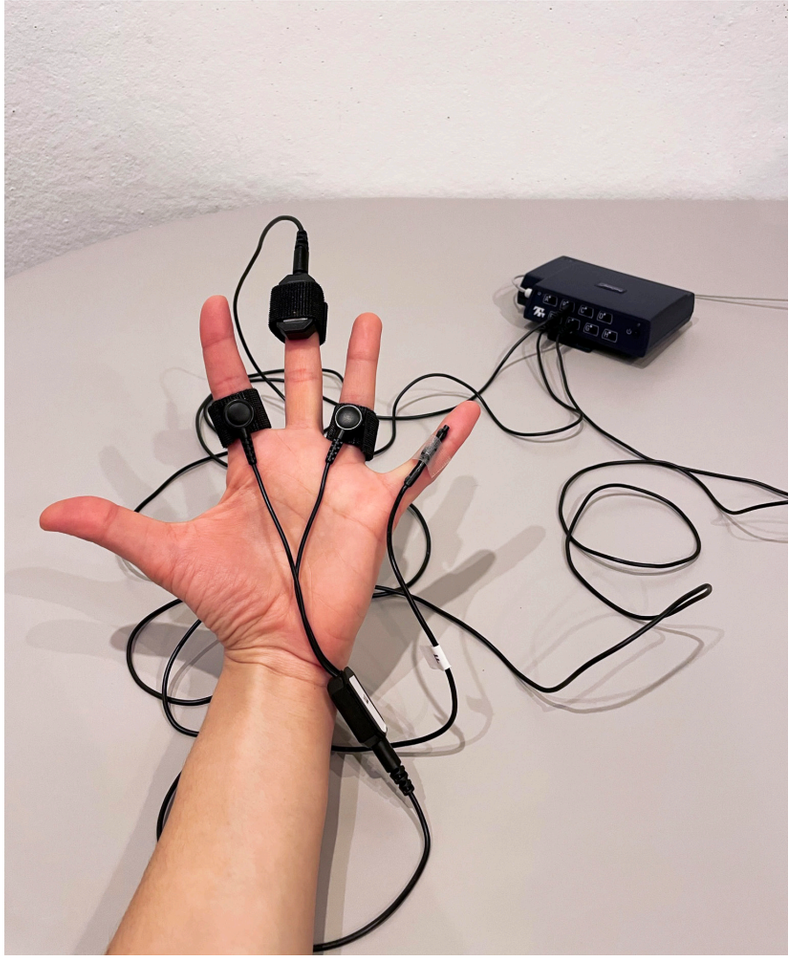
electrodermal activity; [29]

skin temperature; [30]

and *heart rate*. [31]

To better visualize our architectural hypothesis about atmospheric primes, we should imagine the experimental paradigm as an *equation* [**F11**]. Starting and ending rooms are always the same, never changing: same colors, same materials, same proportions, and same light conditions.

F10 RESONANCES
experiment:
wearable sensors for tracking
physiological arousal



30 The *skin temperature* (ST) sensor is designed for continuous temperature monitoring using the skin as an indicator of body temperature, rising in response to higher levels of arousal, independent of valence.
31 In general, an arousal increment correlates to an increase in *heart rate* (HR), determined by the number of heart contractions per minute.

The test subject is the same. They are relatively constant since they cannot modify their psychological and physiological properties significantly in ten minutes, except for the learning effect, which grows after each sequence. Only the corridor changes. *If* a difference emerges in participants' first impressions (nonconsciously and/or consciously: as emotions and/or feelings) when they open the second door, then the corridor's emotional resonance occurred and was intense enough to prime the experience that followed. This few-instant effect on our first impressions proves the presence of an atmosphere in the corridor, capable of emotionally affecting us.

We may have found our way to *see* atmospheres — namely, as we know, the dimension of the ineffable and ephemeral par excellence of our architectural experiences. It is a critical step toward better *understanding architecture* since, as Robert McCarter and Juhani Pallasmaa argue, "architecture has meaning, and matters to us only when it is experienced" (2012, 5). Investigating atmospheric resonance and attunement helps us to decipher the spatial choreography and temporal montage of affective affordances that set the stage for our experiences. The synergy of architecture, biology, and phenomenology is vital in pursuing this research effort about design agency.

F11 Resonance equation
(cf. Canepa 2022b)

- x physiological determinants
- x personal determinants
- x sociocultural determinants
- x spatial determinants
- x experimental determinants
- x priming factor

Atmospheric corridors
randomly tested

C_X [C1, C2, C3, C4]
C_Y [C1, C2, C3, C4]

$$C_X\ [X + X + X + X + X + X] =$$
$$C_Y\ [X + X + X + X + X + X]$$
$$?$$
$$C_X\ [X + X + X + X + X + X] \neq$$
$$C_Y\ [X + X + X + X + X + X]$$

Bibliography

Albright, Thomas D., Thomas M. Jessell, Eric R. Kandel, and Michael I. Posner. 2000. "Neural Science: A Century of Progress and the Mysteries that Remain." *Cell/Neuron* 100 (25: Millennial Review Supplement): s1–s55. DOI: 10.1016/s0896-6273(00)80912-5.

Amiez, Céline and Emmanuel Procyk. 2019. "Midcingulate Somatomotor and Autonomic Functions." In *Handbook of Clinical Neurology*, vol. 166 (Cingulate Cortex), ed. by Brent A. Vogt, 53–71. New York, NY: Elsevier.

Anderson, Ben, and James Ash. "Atmospheric Methods." In *Non-Representational Methodologies: Re-Envisioning Research*, ed. by P. Vannini, 34–51. Routledge Advances in Research Methods. Abingdon and New York, NY: Routledge.

Arbib, Michael A. 2021. *When Brains Meet Buildings: A Conversation between Neuroscience and Architecture*. New York, NY: Oxford University Press (OUP).

Asu Schroer, Sara, and Susanne B. Schmitt (eds.). 2018. *Exploring Atmospheres Ethnographically*. Anthropological Studies of Creativity and Perception. Abingdon and New York, NY: Routledge.

Baiano, Chiara, Xavier Job, Gabriella Santangelo, Malika Auvray, and Louise P. Kirsch. 2021. "Interactions between Interoception and Perspective-Taking: Current State of Research and Future Directions." *Neuroscience and Biobehavioral Reviews* 130: 252–262. DOI: 10.1016/j.neubiorev.2021.08.007.

Bar, Moshe, Maital Neta, and Heather Linz. 2006. "Very First Impressions." *Emotion* 6 (2): 269–278. DOI: 10.1037/1528-3542.6.2.269.

Baricco, Alessandro. 1999. *Ocean Sea* (1993). Transl. by A. McEwen. New York, NY: Alfred A. Knopf.

Barrett, Lisa F., James Gross, Tamlin C. Christensen, and Michael Benvenuto. 2001. "Knowing What You're Feeling and Knowing What to Do about It: Mapping the Relation between Emotion Differentiation and Emotion Regulation." *Cognition and Emotion* 15 (6): 713–724. DOI: 10.1080/02699930143000239.

Barrett, Lisa F., Karen S. Quigley, Eliza Bliss-Moreau, and Keith R. Aronson. 2004. "Interoceptive Sensitivity and Self-Reports of Emotional Experience." *Journal of Personality and Social Psychology* 87 (5): 684–697. DOI: 10.1037/0022-3514.87.5.684.

Barrett, Lisa F., Batja Mesquita, Kevin N. Ochsner, and James J. Gross. 2007. "The Experience of Emotion." *Annual Review of Psychology* 58 (1): 373–403. DOI: 10.1146/annurev.psych.58.110405.085709.

Barrett, Lisa F., and Ajay B. Satpute. 2019. "Historical Pitfalls and New Directions in the Neuroscience of Emotion." *Neuroscience Letters* 693: 9–18. DOI: 10.1016/j.neulet.2017.07.045.

Bell, Lynne, Julia Vogt, Cesco Willemse, Tim Routledge, Laurie T. Butler, and Michiko Sakaki. 2018. "Beyond Self-Report: A Review of Physiological and Neuroscientific Methods to Investigate Consumer Behavior." *Frontiers in Psychology, Personality and Social Psychology* 9: 1655, 1–16. DOI: 10.3389/fpsyg.2018.01655.

Bermúdez, José Luis. 2020. *Cognitive Science: An Introduction to the Science of the Mind* (2010). 3rd edn. Cambridge and New York, NY: Cambridge University Press (CUP).

Bille, Mikkel, Peter Bjerregaard, and Tim F. Sørensen. 2015. "Staging Atmospheres: Materiality, Culture, and the Texture of the In-Between." *Emotion, Space and Society* 15 (Staging Atmospheres): 31–38. DOI: 10.1016/j.emospa.2014.11.002.

Bille, Mikkel, and Kirsten Simonsen. 2021. "Atmospheric Practices: On Affecting and Being Affected." *Space and Culture* 24 (2): 295–309. DOI: 10.1177/1206331218819711.

Bille, Mikkel, and Tim F. Sørensen (eds.). 2019. *Elements of Architecture: Assembling Archaeology, Atmosphere and the Performance of Building Spaces*. Archaeological Orientations, 3. Abingdon and New York, NY: Routledge.

Bloomer, Kent C., and Charles W. Moore, with a contribution by Robert J. Yudell. 1977. *Body, Memory, and Architecture*. New Haven, CT and London: Yale University Press (YUP).

Böhme, Gernot. 1998. "Atmosphäre als Begriff der Ästhetik / Atmosphere as an Aesthetic Concept." *Daidalos. Architektur Kunst Kultur / Architecture Art Culture* 68 (Konstruktion von Atmosphären / Constructing Atmospheres): 112–115.

Borch, Christian (ed.). 2014. *Architectural Atmospheres: On the Experience and Politics of Architecture*. Basel: Birkhäuser.

Bower, Isabella S., Richard Tucker, and Peter G. Enticott. 2019. "Impact of Built Environment Design on Emotion Measured via Neurophysiological Correlates and Subjective Indicators: A Systematic Review." *Journal of Environmental Psychology* 66: 101344, 1–11. DOI: 10.1016/j.jenvp.2019.101344.

Bower, Isabella S., Gillian M. Clark, Richard Tucker, Aron T. Hill, Jarrad A.G. Lum, Michael A. Mortimer, and Peter G. Enticott. 2022. "Built Environment Color Modulates Autonomic and EEG Indices of Emotional Response." *Psychophysiology* 59 (12): e14121, 1–17. DOI: 10.1111/psyp.14121.

Bradley, Margaret M., and Peter J. Lang. 1994. "Measuring Emotion: The Self-Assessment Manikin and the Semantic Differential." *Journal of Behavior Therapy and Experimental Psychiatry* 25 (1): 49–59.

Canepa, Elisabetta. 2022a. *Architecture Is Atmosphere: Notes on Empathy, Emotions, Body, Brain, and Space*. Atmospheric Spaces, 11. Milan and Udine: Mimesis International.

———————— . 2022b. "The Atmospheric Equation and the Weight of Architectural Generators." In *Generators of Architectural Atmosphere*, ed. by E. Canepa and B. Condia, 18–55. Interfaces, 3. Manhattan, KS: New Prairie Press (NPP).

Canepa, Elisabetta, and Bob Condia (eds.). 2022. *Generators of Architectural Atmosphere*. Interfaces, 3. Manhattan, KS: New Prairie Press (NPP).

Canepa, Elisabetta, Valter Scelsi, Anna Fassio, Laura Avanzino, Giovanna Lagravinese, and Carlo Chiorri. 2019. "Atmosphères: Percevoir l'architecture par les émotions. Considérations préliminaires des neurosciences sur la perception atmosphérique en architecture / Atmospheres: Feeling Architecture by Emotions. Preliminary Neuroscientific Insights on Atmospheric Perception in Architecture." *Ambiances. Revue internationale sur l'environnement sensible, l'architecture et l'espace urbain / International Journal of Sensory Environment, Architecture and Urban Space* 5 (Phenomenographies: Describing Urban and Architectural Atmospheres): n.p. DOI: 10.4000/ambiances.2907.

Colombetti, Giovanna. 2017. *The Feeling Body: Affective Science Meets the Enactive Mind*. Cambridge, MA and London: The MIT Press.

Condia, Bob (ed.). 2020. *Affordances and the Potential for Architecture*. Interfaces, 2. Manhattan, KS: New Prairie Press (NPP).

Damasio, Antonio R. 1994. *Descartes' Error: Emotion, Reason, and the Human Brain*. New York, NY: Avon Books.

De Matteis, Federico, Mikkel Bille, Tonino Griffero, and Andrea Jelić. 2019. "Phenomenographies: Décrire la pluralité de mondes atmosphériques / Phenomenographies: Describing the Plurality of Atmospheric Worlds." *Ambiances. Revue internationale sur l'environnement sensible, l'architecture et l'espace urbain / International Journal of Sensory Environment, Architecture and Urban Space* 5 (Phenomenographies: Describing Urban and Architectural Atmospheres): n.p. DOI: 10.4000/ambiances.2526.

Delplanque, Sylvain, and David Sander. 2021. "A Fascinating but Risky Case of Reverse Inference: From Measures to Emotions!" *Food Quality and Preference* 92: 104183: 1–5. DOI: 10.1016/j.foodqual.2021.104183.

Djebbara, Zakaria. 2023. "Rhythms of the Brain, Body, and Environment: A Neuroscientific Perspective on Atmospheres." In *Designing Atmospheres: Theory and Science*, ed. by E. Canepa and B. Condia, 73–111. Interfaces, 4. Manhattan, KS. New Prairie Press (NPP).

Djebbara, Zakaria, Lars B. Fich, Laura Petrini, and Klaus Gramann. 2019. "Sensorimotor Brain Dynamics Reflect Architectural Affordances." *Proceedings of the National Academy of Sciences* (PNAS) 116 (29): 14769–14778. DOI: 10.1073/pnas.1900648116.

Doyen, Stéphane, Olivier Klein, Daniel J. Simons, and Axel Cleeremans. 2014. "On the Other Side of the Mirror: Priming in Cognitive and Social Psychology." *Social Cognition* 32 (Supplement): 12–32. DOI: 10.1521/soco.2014.32.supp.12.

Duff, Cameron. 2010. "On the Role of Affect and Practice in the Production of Place." *Environment and Planning D: Society and Space* 28 (5): 881–895. DOI: 10.1068/d16209.

Edensor, Tim, and Shanti Sumartojo. 2015. "Designing Atmospheres." *Visual Communication* 14 (3: Designing Atmospheres): 251–265 (editorial). DOI: 10.1177/1470357215582305.

Frampton, Kenneth. 1995. "Introduction: Reflections on the Scope of the Tectonic." In *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture*, ed. by J. Cava, 1–28. Cambridge, MA and London: The MIT Press.

Gallagher, Shaun. 1986. "Lived Body and Environment." *Research in Phenomenology* 16: 139–170.

Gallese, Vittorio, and Valentina Cuccio. 2015. "The Paradigmatic Body: Embodied Simulation, Intersubjectivity, the Bodily Self, and Language." *Open MIND* 14 (T): 1–22. Frankfurt am Main: MIND Group.

Gandy, Matthew. 2017. "Urban Atmospheres." *Cultural Geographies* 24 (3): 353–374. DOI: 10.1177/1474474017712995.

Goldhagen, Sarah W. 2017. *Welcome to Your World: How the Built Environment Shapes Our Lives*. New York, NY: HarperCollins.

Griffero, Tonino. 2014. *Atmospheres: Aesthetics of Emotional Spaces* (2010). Transl. by S. de Sanctis. Farnham and Burlington, VT: Ashgate.

———————— . 2019. "Is There Such a Thing as an 'Atmospheric Turn'? Instead of an Introduction." In *Atmosphere and Aesthetics: A Plural Perspective*, ed. by T. Griffero and M. Tedeschini, 11–62. Cham: Palgrave Macmillan.

———————— . 2020a. *Places, Affordances, Atmospheres: A Pathic Aesthetics*. Ambiances, Atmospheres and Sensory Experiences of Spaces, 3. Abingdon and New York, NY: Routledge.

———————— . 2020b. "Better to Be in Tune: Between Resonance and Responsivity." *Studi di Estetica. Italian Journal of Aesthetics*, year XLVIII, series IV, 2 (Sensibilia 13: Resonance): 93–118.

———————— . 2021. *The Atmospheric "We": Moods and Collective Feelings*. Atmospheric Spaces, 10. Milan and Udine: Mimesis International.

Havik, Klaske. 2019. "TerriStories: Outils littéraires pour saisir les ambiances dans le cadre pédagogique du projet d'architecture / TerriStories: Literary Tools for Capturing Atmosphere in Architectural Pedagogy." *Ambiances. Revue internationale sur l'environnement sensible, l'architecture et l'espace urbain / International Journal of Sensory Environment, Architecture and Urban Space* 5 (Phenomenographies: Describing Urban and Architectural Atmospheres): n.p. DOI: 10.4000/ambiances.2787.

Havik, Klaske, Hans Teerds, and Gus Tielens (eds.). 2013. "Building Atmosphere / Sfeer bouwen." *OASE. Journal for Architecture / Tijdschrift voor architectuur* 91 (special issue).

Höök, Kristina. 2018. *Designing with the Body: Somaesthetic Interaction Design*. Design Thinking, Design Theory, 15. Cambridge, MA and London: The MIT Press.

Jelić, Andrea, Gaetano Tieri, Federico De Matteis, Fabio Babiloni, and Giovanni Vecchiato. 2016. "The Enactive Approach to Architectural Experience: A Neurophysiological Perspective on Embodiment, Motivation, and Affordances." *Frontiers in Psychology* 7: 481, 1–20. DOI: 10.3389/fpsyg.2016.00481.

Karakas, Tulay, and Dilek Yildiz. 2020. "Exploring the Influence of the Built Environment on Human Experience through a Neuroscience Approach: A Systematic Review." *Frontiers of Architectural Research* 9 (1): 236–47. DOI: 10.1016/j.foar.2019.10.005.

Kim, Jeongmin, and Nayeon Kim. 2022. "Quantifying Emotions in Architectural Environments Using Biometrics." *Applied Sciences* 12 (19): 9998, 1–22. DOI: 10.3390/app12199998.

Kleinginna, Paul R., and Anne M. Kleinginna. 1981. "A Categorized List of Emotion Definitions, with Suggestions for a Consensual Definition." *Motivation and Emotion* 5 (4): 345–379. DOI: 10.1007/BF00992553.

Küller, Rikard, Seifeddin Ballal, Thorbjörn Laike, Byron Mikellides, and Graciela Tonello. 2006. "The Impact of Light and Colour on Psychological Mood: A Cross-Cultural Study of Indoor Work Environments." *Ergonomics. The Official Journal of the Chartered Institute of Ergonomics and Human Factors* 49 (14): 1496–1507. DOI: 10.1080/00140130600858142.

Lang, Peter J., Mark K. Greenwald, Margaret M. Bradley, and Alfons O. Hamm. 1993. "Looking at Pictures: Affective, Facial, Visceral, and Behavioral Reactions." *Psychophysiology* 30 (3): 261–273. DOI: 10.1111/j.1469-8986.1993.tb03352.x.

Le Corbusier. 1931. *Towards a New Architecture* (1923). Transl. by F. Etchells. London: John Rodker.

———————— . 1948. "Ineffable Space" (1946). In *New World of Space*, 7–9. New York, NY: Reynal and Hitchcock — Boston, MA: The Institute of Contemporary Art.

———————— . 2015. *Precisions on the Present State of Architecture and City Planning: Reprint of the Original American Edition* (1991). Zürich: Park Books — Paris: Fondation Le Corbusier. This work originally appeared in French under the title *Précisions sur un état present de l'architecture et de l'urbanisme* (1930). Paris: G. Crès et Cie.

Leatherbarrow, David. 2015. "Atmospheric Conditions." In *Phenomenologies of the City: Studies in the History and Philosophy of Architecture*, ed. by H. Steiner and M. Sternberg, 85–100. Studies in Architecture, 5. Abingdon and New York, NY: Routledge.

Lohse, Michael, and Morten Overgaard. 2019. "Emotional Priming Depends on the Degree of Conscious Experience." *Neuropsychologia* 128 (Neural Routes to Awareness in Vision, Emotion and Action: A Tribute to Larry Weiskrantz): 96–102.

Mallgrave, Harry F. 2023. "Atmospheric Histrionics." In *Designing Atmospheres: Theory and Science*, ed. by E. Canepa and B. Condia, 133–163. Interfaces, 4. Manhattan, KS. New Prairie Press (NPP).

Mallgrave, Harry F., and Sergei Gepshtein. 2021. "The Interface of Two Cultures." *Intertwining* 3 (Weaving Body Context): 48–73.

McCarter, Robert, and Juhani Pallasmaa. 2012. *Understanding Architecture*. London and New York, NY: Phaidon.

Mostafavi, Armin. 2021. "Architecture, Biometrics, and Virtual Environments Triangulation: A Research Review." *Architectural Science Review* n.n.: 1–18. DOI: 10.1080/00038628.2021.2008300.

Murphy Paul, Annie. 2021. *The Extended Mind: The Power of Thinking outside the Brain*. Boston, MA and New York, NY: Houghton Mifflin Harcourt (HMH).

Nagel, Thomas. 1974. "What Is It Like to Be a Bat?" *The Philosophical Review* 83 (4): 435–450. DOI: 10.2307/2183914.

Osler, Lucy, and Thomas Szanto. 2022. "Political Emotions and Political Atmospheres." In *Shared Emotions and Atmospheres*, ed. by D. Trigg, 162–188. Ambiances, Atmospheres and Sensory Experiences of Spaces, 9. Abingdon and New York, NY: Routledge.

Pallasmaa, Juhani. 2014. "Space, Place and Atmosphere: Emotion and Peripherical Perception in Architectural Experience." *Lebenswelt. Aesthetics and Philosophy of Experience* 4 (1): 230–245. DOI: 10.13130/2240-9599/4202.

———— . 2016. "The Sixth Sense: The Meaning of Atmosphere and Mood." *AD. Architectural Design* 86 (6: Evoking through Design: Contemporary Moods in Architecture): 126–133.

Pérez-Gómez, Alberto. 2016. ***Attunement: Architectural Meaning after the Crisis of Modern Science***. Cambridge, MA and London: The MIT Press.

Peri Bader, Aya. 2015. "A Model for Everyday Experience of the Built Environment: The Embodied Perception of Architecture." *The Journal of Architecture* 20 (2): 244–267.

Pericoli, Matteo. 2022. *Il grande museo vivente dell'immaginazione: Guida all'esplorazione dell'architettura letteraria*. La Cultura, 1651. Milan: il Saggiatore.

Rauh, Andreas. 2018. *Concerning Astonishing Atmospheres: Aisthesis, Aura, and Atmospheric Portfolio*. Atmospheric Spaces, 4. Milan and Udine: Mimesis International.

Schönhammer, Rainer. 2018. "Atmosphere — The Life of a Place: The Psychology of Environment and Design" (2012). In *Designing Atmospheres*, ed. by J. Weidinger, 141–179. Berlin: Universitätsverlag der TU Berlin.

Schreuder, Eliane, Jan van Erp, Alexander Toet, and Victor L. Kallen. 2016. "Emotional Responses to Multisensory Environmental Stimuli: A Conceptual Framework and Literature Review." *SAGE Open* 6 (1): 1–19. DOI: 10.1177/2158244016630591.

Shusterman, Richard. 2006. "Thinking through the Body, Educating for the Humanities: A Plea for Somaesthetics." *The Journal of Aesthetic Education* 40 (1): 1–21.

———— . 2010. "Soma and Psyche." *The Journal of Speculative Philosophy* 24 (3): 205–223.

Soentgen, Jens. 1998. *Die verdeckte Wirklichkeit: Einführung in die Neue Phänomenologie von Hermann Schmitz*. Bonn: Bouvier.

Spence, Charles. 2020. "Senses of Place: Architectural Design for the Multisensory Mind." *Cognitive Research: Principles and Implications* 5: 46, 1–26. DOI: 10.1186/s41235-020-00243-4.

Stec, Barbara. 2020. *Sunlight, Atmosphere and Architecture* (2017). Transl. by K. Barnaś. Kraków: AFM Publishing House.

Subramanian, Sandya, Patrick L. Purdon, Riccardo Barbieri, and Emery N. Brown. 2021. "A Model-Based Framework for Assessing the Physiologic Structure of Electrodermal Activity." *IEEE Transactions on Bio-Medical Engineering* 68 (9): 2833–2845.

Sumartojo, Shanti, and Sarah Pink. 2019. *Atmospheres and the Experiential World: Theory and Methods*. Ambiances, Atmospheres and Sensory Experiences of Space, 2. Abingdon and New York, NY: Routledge.

Tamietto, Marco, and Beatrice de Gelder. 2010. "Neural Bases of the Non-Conscious Perception of Emotional Signals." *Nature Reviews Neuroscience* 11 (10): 697–709. DOI: 10.1038/nrn2889.

Tellenbach, Hubertus. 1968. *Geschmack und Atmosphäre: Medien menschlichen Elementarkontaktes*. Salzburg: Otto Müller.

Tidwell, Philip (ed.). 2014. *Architecture and Atmosphere*. Espoo: Tapio Wirkkala — Rut Bryk (TWRB) Foundation.

Turley, Lou W., and Ronald E. Milliman. 2000. "Atmospheric Effects on Shopping Behavior: A Review of the Experimental Evidence." *Journal of Business Research* 49 (2): 193–211. DOI: 10.1016/S0148-2963(99)00010-7.

Vecchiato, Giovanni, Gaetano Tieri, Andrea Jelić, Federico De Matteis, Anton G. Maglione, and Fabio Babiloni. 2015. "Electroencephalographic Correlates of Sensorimotor Integration and Embodiment during the Appreciation of Virtual Architectural Environments." *Frontiers in Psychology* 6: 1944, 1–18. DOI: 10.3389/fpsyg.2015.01944.

Volgger, Michael, and Dieter Pfister (eds.). 2020. *Atmospheric Turn in Culture and Tourism: Place, Design and Process Impacts on Customer Behaviour, Marketing and Branding*. Advances in Culture, Tourism and Hospitality Research, 16. Bingley: Emerald.

Weidinger, Jürgen (ed.). 2018. *Designing Atmospheres*. Berlin: Universitätsverlag der TU Berlin.

Wigley, Mark. 1998. "Die Architektur der Atmosphäre / The Architecture of Atmosphere." *Daidalos. Architektur Kunst Kultur / Architecture Art Culture* 68 (Konstruktion von Atmosphären / Constructing Atmospheres): 18–27.

Wright, Frank Lloyd. 1992. "In the Cause of Architecture" (1908). In *Frank Lloyd Wright: Collected Writings*, ed. by B.B. Pfeiffer. Vol. 1 (1894–1930), 84–100. New York, NY: Rizzoli, in collaboration with the Frank Lloyd Wright Foundation.

Zamariola, Giorgia, Nollaig Frost, Alice Van Oost, Olivier Corneille, and Olivier Luminet. 2019. "Relationship between Interoception and Emotion Regulation: New Evidence from Mixed Methods." *Journal of Affective Disorders* 246: 480–485. DOI: 10.1016/J.JAD.2018.12.101.

Zumthor, Peter. 2006. *Atmospheres: Architectural Environments. Surrounding Objects*. Basel, Berlin, and Boston, MA: Birkhäuser.

Figure Credits

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Designing Atmospheres: Theory and Science successfully begins to demystify the seemingly ineffable or elusive nature of architectural atmosphere by offering empirical approaches and experiments that, in relation to the clear theoretical and historical background included in its pages (not to mention the prior three Interfaces issues), advance our scientific and phenomenological understanding. The writing is convincing, the intention is clear, the timing is impeccable, the combination of (theoretical, design, historical, and scientific) voices is ideal, and the result is, unsurprisingly, excellent.

—— Julio Bermudez, Ph.D.
ACSA Distinguished Professor
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Is designing atmospheres an easy problem that we can solve scientifically? Or is it a hard problem that must be left to the sensitive experience of the individual architect? This is the scope of both perplexing and tantalizing questions covered by the discussion in **Interfaces 4**. Enjoy!

—— Lars Brorson Fich, Ph.D.
Professor of Architecture
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Entering a room evokes an immediate impression —— it might be pleasant, drab, or even dangerous —— every place has a "pervasive unifying quality" as John Dewey put it, that can instantly shift our mood. Indeed, no space is neutral. Yet, this basic fact seems to have been forgotten. Decades of fascination with form and surface have divested space of place, and the growing concern with atmospheres is now compensating for this impoverishment. This volume, perhaps more than any other on the topic, searches diligently to understand how atmosphere and mood are interlinked, to rigorously question what factors come together to create this unifying quality that we call atmosphere, and how something so basic to human experience could get lost along the way. Coming closer to understanding something as elusive as atmosphere brings us a step closer to understanding ourselves, and our profound interdependence with the world around us. **Hopefully, this new knowledge and awareness may contribute to making places that appeal to the whole of our humanity**.

—— Sarah Robinson
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