



Universiteit
Leiden
The Netherlands

Media Technology

Noctiluca: Evoking Presence Through
Immersive Light and Perceptual Design

Sven Paqué

Supervisors:
Bas Haring & Rob Saunders

MASTER THESIS

Leiden Institute of Advanced Computer Science (LIACS)

www.liacs.leidenuniv.nl

16/02/2026

Abstract

Many everyday moments are spent “in your head”: running internal commentary, rehearsing what to do next, and quietly evaluating yourself and the situation. That mode of attention is useful, but too much of it can also become heavy and make it harder to feel present. In this thesis, I explore how immersive light environments might be designed to ease that self-focused cognitive load and support a more present state through sustained sensory engagement. I use my own working term for this experience: State X, a shift in attention where attention stops circling around judging, planning or replaying but instead stays with what is happening: light, sound, space, and bodily sensation.

Drawing on interdisciplinary literature from psychology, perception research, and immersive art practice, the thesis examines how perceptual strategies such as immersion, spatial enclosure, repetition, ephemerality, and awe shape attention. These concepts are analyzed through existing immersive artworks by James Turrell, Yayoi Kusama, and A.A. Murakami, which suggest that non-narrative, sensory-dominant environments can invite presence without requiring interaction or cognitive control.

Using a research-through-design methodology, these insights are translated into the design and realization of *Noctiluca*, an immersive light and sound installation conceived as a living perceptual field. *Noctiluca* employs slow rhythmic light movement, peripheral stimulation, spatial reorientation, and subtle auditory textures to guide attention outward and reduce cognitive load. The installation functions both as an artistic outcome and as a research artefact through which perceptual strategies are tested through lived experience.

Qualitative reflections from participants, alongside my own engagement with the installation, indicate that *Noctiluca* often supported experiences consistent with State X, including presence, reduced mental urgency, and moments of awe-like absorption. This thesis contributes a reflective framework for understanding how immersive environments can be intentionally designed to invite states of presence through perceptual means.

Contents

1	Introduction	1
2	Background	3
2.1	Immersion	3
2.2	Spatial reference points and attention	4
2.3	Repetition and sensory patterns	5
2.4	Ephemerality and awe	6
3	Methodology	7
3.1	Research-through-design as method	7
3.2	Noctiluca as a research artefact	8
3.3	Design Approach	8
3.4	Evaluation Procedure	9
4	System Design: Noctiluca	10
4.1	Concept and Inspiration	10
4.2	Spatial Setup	11
4.3	Light Behavior	12
4.4	Sound Design	12
4.5	Technical Implementation	12
5	Results	13
5.1	General Experiential Responses	13
5.2	Attention and Presence	13
5.3	Bodily Experience and Scale	14
5.4	Emotional Tone and Awe-Like Qualities	14
5.5	Variability of Experience	14
6	Conclusion	14
6.1	Limitations	15
7	Discussion	15
8	Appendix	16
8.1	Participant 1	16
8.2	Participant 2	17
8.3	Participant 3	17
8.4	Participant 4	18
	References	20

1 Introduction

In everyday life, it's easy to spend a lot of time "in your head": monitoring your own thoughts, planning what to do next, replaying conversations, or thinking about how you come across to others. This kind of self-focused attention is closely tied to internal dialogue, social inhibition, and evaluative thinking [Silvia and Duval, 2001]. It's also useful, we need it to make decisions and navigate social and work situations, but it can sometimes become excessive. Attention keeps looping back into evaluation, thought, and mental rehearsal. In my own words: that is the point where my brain feels "*fried*." In such moments, spontaneity, presence, and emotional openness are easily crowded out. [Smallwood and Schooler, 2013]

What I'm interested in is not "getting rid of the self," but changing what attention is doing for a moment. Sometimes attention is mainly occupied in your head. At other times it is more taken by what is happening right now. Practices like mindfulness training describe this as a shift from being caught up in internal narrative to being more directly engaged with present-moment experience [Farb et al., 2007]. In this thesis, I explore whether immersive sensory environments can invite a similar shift.

Immersive environments are increasingly explored as a way to shape perception and attention. Light-based installations that surround the viewer and soften clear spatial reference points are often described as absorbing and "present" experiences [Lee, 2004]. This characterization is also informed by my own encounters with such works, informal audience accounts, online reviews, and conversations with visitors and artists. These works can hold attention through continuous sensory stimulation, light, movement, enclosure and rhythm, so that attention has less reason to drift into self-monitoring. My idea is that immersion itself can help loosen the grip of internal self-monitoring by giving attention something rich and sustained to rest on.

To talk about the particular experience this article will work on, I introduce my own working term: State X. By State X I mean a shift in attention where experience feels more "in contact" with what is happening around you, and less dominated by inner thoughts. Thoughts and feelings are still there, but they don't automatically pull attention into planning or judgment. People describe something like this in very ordinary moments (music, walking, staring at waves), and also in more intense ones, when something is so engaging that you stop checking yourself for a while. The "clarity" in State X is not that problems are solved; it's that attention is no longer busy running continuous internal problem-solving in the background.

I'm using this term because it matches my own experiences in certain environments, and because it gives me something concrete to design for and reflect on. The question for this thesis is not whether State X is universal in a strict sense, but how particular perceptual conditions might make it more likely to arise.

Experiences of awe are one place where this kind of attentional shift is often reported. Encounters with vast or powerful phenomena, standing at the ocean, looking up at tall trees, can make personal concerns briefly feel smaller, while attention locks onto the sensory scene [Piff et al., 2015]. Research on awe links this to reduced self-focus and increased openness and prosocial feeling. [Piff et al., 2015]

Several contemporary art installations suggest that immersive light environments can also invite comparable ideas.

In James Turrell's Ganzfeld installations, immersion and the removal of stable spatial reference points play a central role in shaping perception. Yayoi Kusama's Infinity Mirror Rooms rely strongly on repetition and visual extension to sustain attention over time. A.A. Murakami's Floating World

emphasizes ephemerality through elements that appear, change, and disappear, such as mist, bubbles, and light.



(a) James Turrell's Ganzfeld installation



(b) Yayoi Kusama's Infinity Rooms



(c) A.A. Murakami's Floating World

Figure 1: The three corresponding art installations

While these works are very different, my personal takeaway is that they can pull attention out of self-monitoring or goal-directed internal thoughts and into an enveloping sensory field. All three combine immersion, attentional guidance, repetition, and ephemerality in distinct ways. These four concepts therefore serve as the main perceptual lenses through which both the artworks and the design of *Noctiluca* are examined and I treat it as something to test through making. At the same time, the effects of these installations are usually described in poetic language or through personal testimony, which makes it hard to translate them into design choices. There is limited research that connects concrete perceptual strategies, enclosure, attentional guidance, repetition, peripheral stimulation, and ephemeral (transient) elements, to reduced self-monitoring and increased presence in a way that is directly useful for designing new work.

The aim of this thesis is to design and reflect on an immersive light installation that invites a state of presence through sensory engagement, referred to here as State X. I explore how such an experience might be supported by translating perceptual strategies I noticed in existing immersive artworks into a new installation, *Noctiluca*. *Noctiluca* is an immersive light and sound environment that uses rhythmic motion, peripheral light dynamics, spatial enclosure, and subtle audio textures to keep attention gently anchored in the room. It is inspired by bioluminescent sea sparkle and by experiences of being in ocean waves, where strong, continuous sensory input can paradoxically feel calming.

Methodologically, this thesis follows a research-through-design approach. Rather than starting with a fixed hypothesis to test, I use the process of designing and building *Noctiluca* as a way of thinking through perceptual questions related to attention and presence. The thesis first introduces four conceptual lenses: immersion, attention, repetition, and ephemerality and relates them to relevant psychological and artistic research. It then presents the design and implementation of *Noctiluca*, followed by an evaluation based on a small number of participant experiences and my own prolonged engagement with the installation. Through this process, I aim to contribute both to artistic practice (by articulating transferable design strategies) and to academic discussions on perception, presence, and immersive environments.

2 Background

2.1 Immersion

Immersion is a widely used but inconsistently defined concept across disciplines such as film, video games, virtual reality and music. Despite its frequent use, there is no single agreed-upon definition, and the term is often used interchangeably with related concepts such as presence and envelopment, contributing to conceptual ambiguity [Agrawal and Bech, 2023].

Across the literature, immersion is most consistently described from a psychological perspective, where it refers to a state of deep mental involvement, in which attention shifts toward the experience itself. [Lombard et al., 2009]. In this view, immersion is not defined by the technological properties of a system alone, but also by how an individual’s attention becomes absorbed. Sensory richness and environmental enclosure are understood as facilitators of immersion, as they help reduce competing stimuli and prevent attentional shifts away from the experience. So when the environment fills more of your senses and your field of view, there is less “elsewhere” for attention to go.

Several authors note that immersion is often mixed up with related concepts, so it helps to separate them. Presence is commonly defined as the sensation of “being there” in a mediated or constructed environment, often associated with spatial illusion or environmental realism [Lee, 2004]. Presence can happen together with immersion, but they are not the same: presence is mainly about perceived location, while immersion is about attentional absorption.

A third related concept is flow. Flow is typically described as an optimal state of experience marked by intense focus, reduced self-consciousness, and a balance between challenge and skill, often in goal-directed or interactive activities [Csikszentmihalyi et al., 2014]. Unlike flow, immersion does not require clear goals, feedback, or interaction, and it can occur in passive situations as well.

Within this diversity of definitions, I use the psychological view of immersion: immersion as sustained attentional involvement, as my working lens in this thesis. It gives me a practical way to look at immersive artworks: not in terms of technology, but in terms of what the environment does to attention.

James Turrell’s installation surrounds the viewer with homogeneous light and it minimizes distinguishable edges or objects, so these environments reduce opportunities for external distraction. The perceptual field itself becomes the object of sustained attention. In this sense, the Ganzfeld works align with state of immersion.

Yayoi Kusama’s Infinity Mirror Rooms similarly support immersion by enclosing the viewer within an extended visual field by the use of mirrors. The lack of a clear boundary between foreground and background encourages attention to remain with the environment as a whole. Although the formal strategies differ from Turrell’s work, the result is comparable: attention is held within the experience.

A.A. Murakami’s Floating World can also be described as immersive through its use of scale and spatial dominance. Large soap bubbles filled with mist drift through the space and pass close to the body, occupying a substantial portion of the perceptual field. This places the viewer within the environment rather than outside it, limiting the possibility of detached observation. The surrounding presence of slow-moving, oversized forms sustains attentional involvement by continuously engaging the viewer’s perceptual system.

None of the installations rely on interaction, but on the maintenance of attentional focus within

a sensory environment.

2.2 Spatial reference points and attention

Spatial reference points and their manipulation play an important role in how environments support the sustained attention that defines immersive experience. Spatial immersion is experienced when an individual has a strong sense of space and enjoys the act of exploration [Agrawal and Bech, 2023]. A.A. Murakami’s Floating World, for example, relies on large-scale spatial elements that surround the body and invite movement through the space. At the same time, research on perceptual environments that lack stable spatial reference points suggests that immersion can also arise through their removal. Studies on the Ganzfeld phenomenon show that exposure to visually homogeneous fields, in which boundaries, depth cues, and focal objects are absent, significantly alters perceptual experience [Avant, 1965]. Rather than producing disorientation alone, such conditions are often described as immersive, as attention shifts away from discrete objects toward the perceptual field itself. Kusama’s Infinity Mirror Rooms achieve a similar effect through infinite mirror reflections.

This perceptual shift can be understood through the distinction between focal and peripheral vision. Focal vision is what you use to inspect details straight ahead, while peripheral/ambient vision is what gives you a sense of the surrounding space and picks up motion at the edges. Focal vision supports object recognition and cognitive control, whereas peripheral or ambient vision is primarily involved in bodily orientation and coupling with the environment. [Gibson, 1979]. When an environment offers no clear focal point, attention is less likely to lock onto individual objects and more likely to spread across the field [Styles, 2006]. Perception becomes more ambient and less driven by active interpretation. In such conditions, attention appears less drawn into self-monitoring and more able to rest on the sensory environment itself.

A useful second framework to understand this shift is offered by Attention Restoration Theory (ART). ART argues that directed or voluntary attention is a finite resource that becomes fatigued after sustained effortful tasks that require focus and executive control. [Kaplan et al., 1989, Kaplan, 1995]. When directed attention is depleted, people tend to show poorer self-regulation and decision-making [Hare et al., 2009, Vohs et al., 2008, Fan and Jin, 2014]. According to ART, certain environments support recovery by reducing demands on directed attention and encouraging more effortless bottom-up forms of engagement.

Kaplan describes these restorative environments as offering a sense of being away from everyday demands, along with a more open mode of experience and what he calls soft fascination: stimuli that hold attention without requiring effortful control [Kaplan, 1995, Staats, 2012]. Although ART was developed in relation to natural environments, its underlying attentional mechanisms are not limited to nature. Environments that minimize the need for selection, interpretation, and goal-directed focus may similarly allow executive attentional processes to disengage.

Immersive light installations can be approached in this way as well. What matters is not how much sensory input an environment provides, but whether attention is asked to actively do something with it. Environments such as James Turrell’s Ganzfeld installations, Yayoi Kusama’s mirror rooms and A.A. Murakami’s Floating World offer perceptual situations that do not demand such active control. Clear spatial reference points are softened or removed, and there is no task, instruction, or correct way to engage. Attention can remain with the sensory situation itself, without having to plan, choose, or interpret.

Without a fixed foreground or focal object, attention tends to spread across the perceptual field

rather than locking onto individual elements. This supports a more diffuse mode of attention, in which awareness stays with what is happening, rather than looping back into self-monitoring or internal evaluation. In this sense, immersive light installations can create conditions that resemble what I refer to in this thesis as State X.

2.3 Repetition and sensory patterns

Building on the role of immersion and attention, repetition can be understood as a perceptual strategy that stabilizes attention over time. In environments where sensory patterns repeat, such as waves or breathing rhythms, attention often relaxes into the pattern instead of actively tracking change. In immersive environments, repetitive sensory patterns, such as rhythmic light movement can make perception feel easier to follow, because there is less need to constantly interpret what is happening [Reber et al., 2004]. Repetition reinforces familiar input and reduces surprise-driven shifts of attention, which can lower the load on working memory [Grill-Spector et al., 2006]. Rather than asking the viewer to constantly decide where to look or how to respond, repetitive environments allow attention to settle into the experience itself.

Empirical studies on visual repetition in natural contexts support this effect. Research on fractal patterns, characterized by self-similar repetition across scales, shows that mid-complexity fractals can ease visual processing and reduce physiological stress responses, likely by lowering cognitive and visual strain [Taylor et al., 2005, Taylor et al., 1999]. Studies on creative practices such as drawing, coloring, or pattern-making have shown that simple, repetitive actions can elicit flow-like experiences [Forkosh and Drake, 2017]. Such findings suggest that repetition does not dull experience, but can instead create conditions in which perception remains active without becoming demanding.

When the sensory field stays coherent and continuous, attention does not have to keep re-orienting, and it becomes easier to stay with the experience rather than drifting into self or goal-referential thought. This mode of engagement aligns with descriptions of absorption, in which individuals become deeply involved in an experience while self-awareness and time perception recede [Roche and McConkey, 1990].

However, repetition alone does not account for the full impact of immersive environments. While repetition stabilizes attention and reduces cognitive load, it creates a steady sensory context in which variations, disruptions, or fading elements stand out more clearly. In this sense, repetition prepares attention for experiences shaped by ephemerality and impermanence. When repetition is combined with subtle change or impermanence, attention may remain anchored while expectations are gently disrupted, opening the way for stronger sense of presence, emotional resonance, and experiences commonly described as awe.

This fits with prediction-error accounts of aesthetic experience, which argue that artworks often become engaging when they build a pattern you can start to follow, and then introduce small violations that keep perception active and rewarding [Van de Cruys and Wagemans, 2011]. In *Noctiluca*, repetition provides the stable “ground” for attention to settle into, while gradual variation and impermanence prevent the experience from becoming fully predictable.

This interplay between repetition and ephemerality is central to the next section, which examines how transient, unstable, or overwhelming perceptual phenomena further shift attention away from control and prediction, toward surrender, openness, and expanded awareness.

2.4 Ephemerality and awe

While repetition stabilizes attention and supports sustained presence, immersive environments often also rely on ephemerality and change. Ephemeral perceptual elements, such as shifting light, fading forms, mist, or unpredictable motion, introduce instability into the sensory field. Unlike repetition, which creates continuity, ephemerality resists fixation and control. What is perceived cannot be fully anticipated, held, or repeated in the same way, requiring attention to remain closely tied to the unfolding present moment.

From an attentional perspective, ephemerality limits the effectiveness of prediction and planning. When sensory conditions are transient or continuously changing, attention cannot rely on habitual patterns or expectations. Instead, perception must remain responsive and open, reducing opportunities for internal rehearsal, evaluation, or self-monitoring. This complements the effects of repetition: while repetition lowers cognitive load and anchors attention, ephemerality prevents attention from becoming rigid or disengaged.

Psychological research on awe provides a useful framework for understanding the experiential effects of such perceptual conditions. Awe is commonly defined as an emotional response to experiences that are perceptually or conceptually vast and that challenge existing frames of reference [Keltner and Haidt, 2003]. In this view, awe arises when individuals encounter stimuli that exceed their usual capacity for understanding, so the mind has to adjust how to make sense of it. Such experiences often occur at the limits of perception, where sensory input or scale becomes difficult to fully process. Empirical research supports this view. Piff et al. describe awe as a response to perceptually vast stimuli that diminish self-focus and promote a sense of the “small self,” a temporary reduction in self-importance associated with increased prosocial behavior and emotional openness [Piff et al., 2015]. Notably, even brief exposure to perceptually vast environments can elicit these effects. In one study, participants who spent a short time looking up at tall trees reported greater awe, reduced self-focused attention, and increased helping behavior compared to those who viewed an ordinary building [Piff et al., 2015]. These findings demonstrate that awe does not require narrative or symbolic meaning, but can arise directly from perceptual experience.

Environmental psychology research shows that impermanent natural phenomena, such as sunrises, storms, or rainbows, often elicit stronger feelings of awe and appreciation than stable conditions [Smalley and White, 2023]. What seems important here is not unpredictability in a random sense, but impermanence. In my own experience, these moments feel powerful precisely because they unfold in time and cannot be held or repeated at will. As they appear and fade, attention is drawn into the unfolding moment and becomes temporarily absorbed, often interrupting the usual autopilot of perception. Awe-inducing experiences are therefore frequently described as involving intense attentional capture or a brief form of “attentional freezing,” in which attention remains fully with the stimulus.

At the extreme, awe can arise near the limits of perceptual processing, where sensory input becomes unusually intense or ambiguous. Research on highly intense or novel sensory experiences suggests that moments of sensory overload or, conversely, perceptual emptiness, can interrupt normal cognitive processing and induce feelings of vastness and wonder [Yaden et al., 2019]. In such moments, habitual modes of perception and self-referential thought are temporarily suspended.

Immersive art installations often employ these perceptual conditions deliberately. In James Turrell’s Ganzfeld installations, homogeneous light fills the visual field and removes depth cues, producing a sense of boundless space that challenges perceptual orientation. Yayoi Kusama’s

Infinity Mirror Rooms use repetition and reflection to create the illusion of endless extension, evoking feelings of self-diminishment and perceptual vastness. A.A. Murakami’s Floating World focuses on ephemerality through mist, bubbles, and light that appear and disappear, emphasizing impermanence rather than unpredictability. Across these works, awe emerges not through narrative content, but through perceptual strategies that exceed ordinary attentional and interpretive capacities.

Alongside repetition, ephemerality helps to create a balance between stability and change. Repetition provides a rhythmic perceptual ground that supports sustained attention and reduces cognitive effort, while ephemerality prevents the experience from becoming static, so that it keeps attention alert and externally oriented. This suggests that immersive artworks are more than aesthetic experiences: they can be carefully constructed perceptual environments designed to guide attention. These insights form the basis for the design of *Noctiluca*, which translates these shared strategies into a new immersive light installation aimed at evoking State X.

3 Methodology

I approached this project through research-through-design: I develop understanding by building, experiencing, and adjusting a concrete artefact. In this thesis, I use *Noctiluca* as the main way to explore how immersive conditions shape attention, presence, and self-monitoring. Instead of designing something first and only then analyzing it from a distance, I used the design process itself as a way to learn. I made concrete choices (about light movement, spatial layout, sound, and pacing), spent time with the installation as it evolved, and reflected on how those changes affected the experience. In that sense, the installation functions both as the artistic work and as the practical context in which the central ideas of this thesis are tested and refined.

3.1 Research-through-design as method

Research-through-design is particularly suited to questions that are about subjective experience, perception, and embodied interaction, where this cannot be fully measured or understood through analytical or theoretical approaches alone. State X, as I use the term in this thesis, is qualitative and strongly shaped by context. Because of that, I did not treat the work as something to “test” in a classical experimental sense. Instead, I used iterative making and repeated experience as my main way of learning which perceptual conditions made State X more likely to arise.

The research process began with close examination of existing immersive artworks like installations by James Turrell, Yayoi Kusama, and A.A. Murakami that I have personally experienced as inducing a strong sense of presence and reduced self-monitoring. Rather than taking these experiences at face value, I sought to understand why such works might produce these effects. This involved an iterative process of:

1. Experiencing and analysing existing artworks
2. Identifying recurring perceptual characteristics
3. Relating these characteristics to concepts from psychology, perception research, and attentional theory

4. Translating these insights into concrete design decisions
5. Reflecting on the resulting experiences

Design and reflection did not occur as separate phases, but rather simultaneously. While constructing *Noctiluca*, theoretical concepts such as immersion, diffuse attention, repetition, ephemerality, and awe informed design choices in real time. When uncertainty arose, for example regarding spatial layout or perceptual intensity, I addressed these questions through small-scale tests, observation, and further consultation of relevant literature. In this way, making and thinking remained tightly interwoven throughout the project.

3.2 *Noctiluca* as a research artefact

Building *Noctiluca* was essential to the research, as the questions addressed in this thesis concern situated, embodied experience. The effects explored here cannot be fully validated through theory alone; they emerge through direct sensory engagement within a physical environment.

By constructing an immersive installation and spending time within it, both alone and with others, I was able to examine whether the perceptual strategies identified in the literature and in existing artworks actually functioned as expected. For example, concepts such as diffuse looking or unpredictable change could be tested not abstractly, but through lived experience: Did these elements support sustained attention? Did they reduce the tendency toward internal evaluation? Did they invite surrender rather than control?

Such insights would not have been accessible through analysis alone. The installation allowed theory to be materialized, questioned, and refined through practice. However, it does not claim that *Noctiluca* objectively induces State X in all participants, nor that specific perceptual mechanisms operate in isolation. Instead, it offers a reflective framework for understanding how immersive environments can be designed to invite states of presence by reducing cognitive load and encouraging sustained sensory engagement.

3.3 Design Approach

The early versions of *Noctiluca* were approached as experiential tests. The installation takes the form of an immersive light environment composed of vertically oriented LED poles, two meters in height, arranged around a stationary viewer in a seated or reclining position. A semi-circular spatial layout was used to surround the viewer without fully enclosing the space. The vertical scale of the poles, combined with the lowered position of the viewer, was chosen to alter bodily perspective and evoke a sense of perceptual vastness. This design decision was guided by research on awe, in which encounters with large-scale phenomena can reduce self-focus by directing attention toward something experienced as greater than oneself. Similarly, the semi-circular arrangement of the poles was designed as a way to engage peripheral vision. While the viewer's focal attention might rest on a single pole, movement and light at the edges of the visual field contribute to a more diffuse attentional state. This configuration was also experientially confirmed during engagement with the installation, where attention gradually shifted from individual elements toward the perceptual field as a whole. Another explicit design intention throughout *Noctiluca* was to achieve immersion through a limited set of simple components and rules, rather than through large architectural structures or visually elaborate systems. I chose this approach partly for practical reasons (budget

and space) and also because I wanted the experience to rely on subtle attentional conditions rather than on obvious spectacle.

The perceptual parameters were explored iteratively. Parameters such as light intensity, speed, rhythm, spatial spacing, and the balance between repetition and variation were repeatedly adjusted and evaluated through embodied experience. For example, excessive randomness resulted in a loss of coherence and attentional anchoring, while overly rigid repetition felt monotonous and disengaging. Through iterative testing, randomness was gradually constrained to support continuity without predictability. Rhythm was similarly refined: faster movements increased arousal and cognitive activation, while slower, more continuous motion supported calm and sustained presence. Ultimately, rhythmic behavior was embedded in the system by slowly modulating the Perlin noise over time, so the rhythm would naturally emerge from the same underlying movement. That way the installation kept feeling like one continuous, living light field, instead of a series of separate, pre-programmed scenes or effects switching on and off.

Decisions about whether an element “worked” were based primarily on experiential criteria: bodily sensation, perceived calm, reduced urgency to act or think, and the ability to remain with the experience over time. Anything that pulled attention into distraction, story, or control was stripped away. For example, I dropped more dramatic transitions and strobe-like moments because they immediately introduced a sense of “something happening” in a staged way and that didn’t fit the open, drifting quality I was aiming for.

Throughout the design process, theoretical concepts functioned as guiding lenses rather than strict rules. Ideas such as immersion, diffuse attention, repetition, ephemerality, and awe informed design intuition and helped interpret experiential outcomes, but they did not prescribe fixed solutions. Most decisions came from going back and forth between reading, making, and then spending time in the installation to see what actually changed.

Interaction and explicit user control were intentionally avoided. As soon as people can “do” something to the system, attention tends to shift into agency: choosing, checking, adjusting, monitoring whether it responds. That kind of engagement easily brings self-awareness and goal-oriented thinking back in, which would counteract the aim of reducing cognitive effort and encouraging perceptual surrender. Instead, engagement was guided solely through sensory conditions, allowing attention to be shaped by the environment rather than by conscious decision-making.

Overall, *Noctiluca* was developed through repeated making and experiencing, guided by both theory and practice, to explore which perceptual strategies could support State X.

3.4 Evaluation Procedure

The evaluation of *Noctiluca* was conducted in an exploratory and reflective manner, consistent with the research-through-design approach adopted in this thesis. I collected detailed reflections from four participants (see Appendix), complemented by my own prolonged engagement with the installation. In addition, I had several shorter informal conversations with participants, which informed my interpretation but are not treated as primary material in the Results chapter. Experiences took place both individually and, in some cases, together with me (in silence). The installation was presented in a darkened environment, such as a studio, with no external light sources so that the perceptual conditions were shaped by the installation itself. Visitors were not given a fixed duration and were free to remain in the space for as long as they wished.

Feedback was gathered informally through open-ended conversations following the experience.

Participants were invited to describe what they felt, how they experienced the space, and whether the installation affected their sense of presence, calm, or self-focused thought. No structured questionnaires, standardized measures, or comparative conditions were used. The collected responses are therefore qualitative, subjective, and descriptive in nature.

4 System Design: Noctiluca

Noctiluca is an immersive light and sound installation designed as a perceptual environment. Visitors enter the installation and settle into a seated or lying posture, staying in the space for as long as they want. The work presents itself as a continuously evolving field of light and sound that does not demand interaction or interpretation. *Noctiluca* operates as a living perceptual system in which changes happen slowly and gradually, so the installation feels alive, allowing each experience to be unique.

The installation is based on 12x 2-meter LED poles arranged in a half circle that create a perceptual field that surrounds the viewer. A subtle layer of sound and mist further shapes the space, supporting a sense of immersion and spatial coherence. Together, these components form *Noctiluca*.

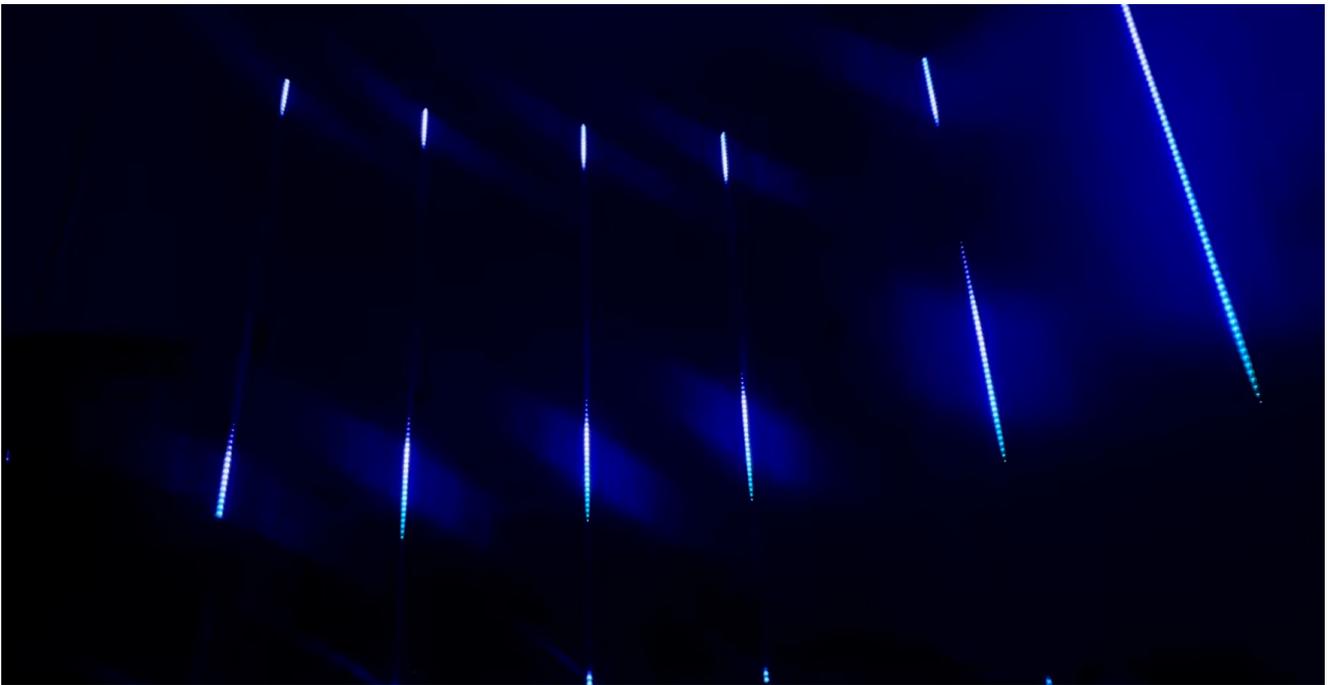


Figure 2: Still from short video showcasing Noctiluca. *The full video is available at: <https://youtu.be/On7JVyæ1æpM?si=GXMScyM-EfhvdQHj>*

4.1 Concept and Inspiration

The name *Noctiluca* comes from the Latin term for bioluminescent sea sparkle, a natural phenomenon in which microscopic organisms emit light when disturbed by waves or movement. Sea sparkle

became a central reference point for this project, both conceptually and aesthetically. In my own experience, encounters with sea sparkle and with other natural light phenomena like the Northern Lights can feel awe-like: visually intense, but at the same time calming; structured, yet never fully predictable.

These natural experiences informed both the visual language and the experiential ambition of the installation. *Noctiluca* does not try to copy nature literally. Instead, it translates some of the qualities that make these phenomena compelling such as flowing motion, soft shifts in colour, and organic variation into an artificial system of light. The emphasis is on evoking similar perceptual responses: a sense of being immersed in something larger than oneself, surrendering to rhythm, and allowing attention to settle without effort.

Natural environments like the ocean, breaking waves, or a sky filled with Northern Lights often hold this strange combination of intensity and calm. They can exceed ordinary perceptual scale while remaining non-threatening, and that kind of sensory saturation can paradoxically bring mental clarity [Piff et al., 2015]. *Noctiluca* tries to recreate that same balance, but inside an artificial environment.

4.2 Spatial Setup

The spatial design of *Noctiluca* plays a central role in shaping how the installation is perceived and experienced. The LED poles are positioned in a semi-circular formation, surrounding the participant without fully enclosing them.

The LED poles were chosen deliberately instead of walls, screens, or projections. By working with slender light sources rather than large continuous surfaces, the installation explores how immersion can be achieved through minimal means. Visitors are invited to sit or lie down on pillows placed close to the ground, altering their usual bodily perspective. From this position, the surrounding light elements appear taller and more dominant, subtly shifting the perceived relationship between the self and the environment.

The semi-circular arrangement supports diffuse attention by activating the edges of the visual field. Even if a viewer’s focus lands on one pole, movement in the neighbouring poles stays visible at the peripheral vision. This discourages narrow focal fixation and makes it easier for attention to spread across the whole field. I avoided a full circle on purpose: it would encourage people to keep turning their head and body to “scan” the space. That kind of movement brings back a feeling of agency and control, while *Noctiluca* is meant to be experienced from a relatively still, receptive posture.

A subtle haze is introduced to soften light boundaries and reduce background contrast. The haze reduces the visibility of stable visual anchors (e.g., corners, walls, and distant objects) that typically support orientation in a room. As these reference points become less readable, the space is experienced as less fixed and less easily mapped, shifting perception away from the surrounding architecture and toward the LED poles as the primary points of reference. In this way, the haze supports the intended receptive posture of *Noctiluca* by reinforcing an attentional bias toward light and motion rather than spatial navigation.

4.3 Light Behavior

The behavior of light in *Noctiluca* is designed to feel organic, continuous, and non-deterministic. The system is driven by slowly evolving noise processes that generate movement across the vertical LED poles. These processes produce soft, flowing structures that appear, shift, connect, and dissolve over time.

At a perceptual level, the light often appears as thin lines or bands that stretch across one pole or several at once. These lines may remain stationary for extended periods, drift slowly across the space, or move from left to right or bottom to top. Every now and then, patterns line up and “merge” together, creating brief moments of increased visual intensity before dispersing again. These larger events are not scripted but emerge from the interaction of simple underlying rules.

The light system is intentionally “non-repeating but coherent.” While similar movements may recur, their exact timing, scale, and configuration are never identical. This avoids predictability without descending into chaos. Slow modulation ensures that changes remain followable, allowing attention to stay engaged without becoming overstimulated. Early iterations with higher levels of randomness resulted in visual overload and made it difficult to remain present. By reducing speed and narrowing variation, the installation started to support a calmer, more sustained kind of attention.

Subtle additional behaviors are layered onto this base system, such as brief shifts in color temperature or moments of expanded brightness. These occur infrequently and for short durations, introducing more ephemerality without interrupting the overall continuity of the experience. The light therefore behaves less like a sequence of effects and more like a single evolving organism, reinforcing the sense of immersion.

4.4 Sound Design

Sound in *Noctiluca* functions as a supportive layer rather than a leading element. Its primary role is to stabilize the perceptual environment and reduce external distractions. Silence was avoided, as it would allow incidental sounds from outside the installation, such as footsteps or distant noise, to draw attention back toward the external world and reintroduce self or goal-oriented thought.

The soundscape is built around a low-frequency brown noise base, which provides a warm, grounding presence. Over this base, subtle environmental textures are layered, including distant wave-like sounds and faint natural elements such as birds or animals. These sounds are not meant to be identifiable or narratively meaningful, but to evoke a vague association with natural environments.

Rhythm and melody were deliberately avoided. Structured musical elements risk creating expectation, anticipation, and cognitive engagement. Instead, the sound remains amorphous and non-repeating, allowing it to fade into the background while still contributing to the immersive atmosphere. In this way, sound supports the visual experience by reinforcing continuity and enclosure without competing for attention.

4.5 Technical Implementation

The installation uses individually addressable LED strips (WS2815) mounted within vertical profiles, allowing control over brightness and color across each element.

TouchDesigner serves as the primary environment for generating the visual behavior of the system. Its node-based structure allows complex noise processes, modulation, and feedback to be constructed from simple components. Visual data is generated in a two-dimensional space and mapped onto the vertical light poles before being transmitted via Art-Net. The data is structured as DMX universes and converted by a custom controller into signals that the LED strips can interpret.

Once activated, the system runs autonomously. There is no user input, interaction, or manual control during operation. The installation continuously generates new configurations based on its internal logic, ensuring that no two moments are identical.

5 Results

This section reflects on the experiences that emerged during encounters with *Noctiluca*. Instead of presenting measured effects or statistically analyzed data, I draw on qualitative descriptions shared by four participants, together with my own observations formed through prolonged engagement with the installation. The aim is not to generalize, but to articulate the experiences that appeared across these encounters and to reflect on how they relate to the experiential condition described in this thesis as State X.

5.1 General Experiential Responses

Within this small group of participants, *Noctiluca* was often described as calming, immersive, and absorbing. Four participants noted a reduction in mental activity after settling into the space, frequently describing a sense of “slowing down” or “letting go” shortly after entering the installation. These descriptions closely resembled my own experiences during extended periods spent within the installation. A recurring observation was that the experience did not feel goal-oriented or demanding. Some participants noted that at the beginning of the experience they were still searching for meaning or direction, but that this gradually shifted toward simply experiencing the installation. The absence of interaction, instruction, or narrative progression was mentioned as allowing participants to simply “be” with the environment, rather than trying to understand or interpret it. This aligns with the installation’s intention to reduce self-monitoring and active cognitive control.

5.2 Attention and Presence

Across participant reflections and my own observations, attention appeared to shift toward a more present and less internally occupied state. Participants described becoming absorbed in the slow movement of light, the surrounding spatial field, and the subtle interplay between repetition and change. In some cases, thoughts were reported to move away from everyday concerns toward more open or reflective forms of thinking. One participant explicitly described a heightened sense of presence, using the term ‘grounding’. A recurring experiential pattern involved a shift in attentional focus: after initially attending to a single LED pole, perception gradually expanded to include the installation as a whole. This attentional broadening, which I also experienced repeatedly, is consistent with the diffuse mode of attention discussed earlier in this thesis.

5.3 Bodily Experience and Scale

The seated or reclining posture, combined with the vertical scale of the surrounding light elements, influenced how participants experienced their bodies in relation to the environment. Some described feelings of awe, while others referred to a sense of being “held” or “contained” by the space. Participants generally remained physically still during the encounter, with minimal head or body movement. This stillness was not described as restrictive, but rather as comfortable and supportive of a receptive mode of engagement. The bodily orientation appeared to discourage active exploration and instead supported sustained perceptual attention.

5.4 Emotional Tone and Awe-Like Qualities

While emotional responses varied, all participants described moments of quiet intensity or subtle wonder. These moments were not experienced as dramatic events, but as gentle shifts within an otherwise stable perceptual field. Some participants associated these moments with feelings of awe, calm curiosity, or emotional openness. Rather than producing excitement or stimulation, these experiences were characterized by a form of alert calm. Participants often described leaving the installation feeling mentally clearer or emotionally lighter. In some cases, this clarity was accompanied by a specific reflection or insight whilst contemplating; in others, it was described more as a general sense of openness or ease.

5.5 Variability of Experience

Importantly, experiences of *Noctiluca* were not uniform. While most participant reflections aligned closely with the intended experiential condition of State X, one described forms of engagement shaped by personal associations or emotional states unrelated to the installation’s design intent. This diversity of responses underscores the subjective and situated nature of immersive experience and supports the decision to treat these observations as reflective insights rather than as evidence of a single, universal effect.

6 Conclusion

This thesis set out to design and reflect on an immersive light installation that invites a state of presence through sensory engagement. By combining the analysis of immersive artworks with relevant literature and an iterative build process, this research demonstrates that such experiences can be shaped through perceptual strategies rather than narrative, interaction, or explicit instruction. In my case, *Noctiluca* suggests that immersive light environments can support presence by stabilizing attention, reducing cognitive effort, and gently exceeding ordinary perceptual expectations. Elements such as spatial enclosure, altered bodily perspective, repetition and ephemerality all work together to shift attention away from internal self-monitoring and toward immediate sensory experience.

Building *Noctiluca* enabled insights that would not have been accessible through theory alone. The work confirmed some initial assumptions, particularly regarding the role of immersion, repetition, and awe, while also challenging the tendency toward excess or over-design. One key insight was that less structure, when carefully tuned, can create a stronger experiential effect than more complexity.

The installation demonstrated that presence does not emerge from stimulation alone, but from a careful balance between stability and change.

In terms of contribution, this thesis offers a combined conceptual, experiential, and design-oriented perspective on immersive light installations. Conceptually, it brings together insights from perception research, attention theory, and psychological studies of awe to frame immersive artworks as perceptual environments. Experientially, it reflects on State X as a subjective yet recurring mode of engagement characterized by calm, openness, and reduced self-focus. From a design perspective, it offers a set of transferable strategies of how an immersive light environment can be built to make State X more likely to arise.

6.1 Limitations

At the same time, this research has clear limitations. The evaluation of *Noctiluca* was qualitative, informal, and reflective rather than systematic. Individual perceptual mechanisms were not isolated or tested independently, and no physiological or behavioral measurements were conducted. This means I cannot make strong causal claims about what “works” in general, or for everyone. That limitation is also part of the approach I chose. Research-through-design is not aimed at proving that single variables reliably produce single outcomes. Instead, it is a way of learning through making and through situated, embodied experience: how a set of perceptual strategies behaves when it is combined into one coherent environment. A more controlled empirical study could be a valuable next step, but it would be a different kind of project, with different aims, rather than a replacement for the work done here.

7 Discussion

Compared to the artworks that influenced this project, *Noctiluca* shows both similarities and differences. Like Turrell’s Ganzfeld environments, it softens clear spatial reference points and encourages diffuse attention. At the same time, *Noctiluca* is not perceptually still: it includes continuous motion and slow temporal variation. Compared to Kusama’s Infinity Mirror Rooms, which lean heavily on repetition and visual infinity, *Noctiluca* avoids multiplication and spectacle. Instead, it relies on slow, organic transitions that resist immediate interpretation. Compared to Murakami’s Floating World, which foregrounds ephemerality through visible creation and disappearance, *Noctiluca* integrates impermanence more subtly, embedding change within an ongoing, self-sustaining perceptual field. These differences suggest that awe and presence can be elicited through multiple perceptual pathways, and that immersive calm does not require dramatic events or explicit metaphors.

A thing that stood out in this project is the role of non-control in immersive experience. *Noctiluca* supports a mode of engagement closer to perceptual surrender than exploration or problem-solving. This positions the work closer to absorptive states than to interactive immersion typically emphasized in digital media and virtual environments.

Another observation surprised me at first, but kept coming back in participant accounts: people often felt that sound and light were meaningfully connected, even though they were not technically synchronized. For example, moments in which a sound coincided with a change in light movement were interpreted as intentional or responsive, despite being the result of independent, stochastic

processes.

This phenomenon highlights a fundamental aspect of human perception: the tendency to seek patterns, coherence, and causal structure within complex or uncertain environments. If the environment does not tell you what it means, you start making meaning anyway: by linking events, noticing patterns, and forming your own explanations. In the context of *Noctiluca*, this suggests that reduced narrative control and increased perceptual ambiguity do not eliminate meaning-making. It allows interpretation to emerge subjectively rather than being imposed by the system.

From an experiential perspective, this pattern-seeking behavior may contribute to absorption rather than distraction. Because the perceived relationships were never fully confirmable, attention stayed engaged without “solving” the system once and for all. It created a loop of curiosity that felt calm rather than restless. This aligns with psychological accounts of awe and perceptual openness, in which the need for cognitive accommodation is activated without being fully resolved. Rather than clarifying the system, the experience sustains curiosity, presence, and attentional surrender.

8 Appendix

This appendix contains personal reflections shared by individuals who experienced *Noctiluca*. These accounts are included to provide additional context for the experiential themes discussed in the Results section. The reflections are presented in the participants’ own words and are not intended as systematic data, but as situated, subjective impressions that informed the interpretation of the installation. The reflections were originally written in Dutch and have been translated into English as literally as possible. I chose this word-for-word approach to preserve the participants’ phrasing and meaning, even if it results in less natural English.

8.1 Participant 1

(Participant experienced the installation lying down for approximately 30 minutes.)

Dutch:

”Ik lag op de grond in de donkere ruimte en keek naar de ledpalen. De palen lichtte op, soms traag en soms snel. Ze vloedde in elkaar over, maar soms was er ook een enkele die individueel oplichtte. Ik begon langzaam op te gaan in de patronen die ik dacht te zien, ritmes en overeenkomsten tussen verschillende momenten. Ik ervaarde de soundscape als een antwoord op de ledlichten, ze leken samen één geheel. De ervaren bracht mij ook even mee naar een ander soort plek. Het deed mij denken aan ervaringen in de natuur waar je even niets hoefde te doen buiten kijken, luisteren en ervaren. Het volgen van de ledlichten voelde als een soort opbouwend verhaal waar nooit echt een einde of een hoogtepunt in zat. Gewoon meekabbelen op de stroming van de lichtten en het geluid, en dat maakte het zeer rustgevend.”

English:

“I lay on the ground in the dark space and looked at the LED poles. The poles lit up, sometimes slow and sometimes fast. They flowed into each other, but sometimes there was also a single one that lit up individually. I slowly began to go up in the patterns that I thought I saw, rhythms and similarities between different moments. I

experienced the soundscape as an answer to the LED lights, they seemed together one whole. The experience also took me for a moment to another kind of place. It made me think of experiences in nature where you for a moment didn't have to do anything besides looking, listening and experiencing. Following the LED lights felt like a kind of building-up story that never really had an end or a climax. Just drifting along on the flow of the lights and the sound, and that made it very calming.”

8.2 Participant 2

(Participant experienced the installation sitting and then lying down for approximately 30 minutes.)

Dutch:

”Ik ging eerst zitten en vond het lastig om erin te komen, ik had geen idee wat ik nou precies moest doen. Toen ging ik liggen en had het gevoel dat het makkelijker was de palen te volgen, Sven zei dat ik kon liggen of zitten maar merkte dat bij liggen die palen soortvan groter oogte en dat vond ik wel een fijn gevoel, dat ik echt 'erin' zat. Eerst keek ik steeds naar één specifieke LED paal en ging veel met mijn hoofd draaien heen en weer om elke paal apart te zien, maar na een tijdje leek het alsof ik het geheel zag terwijl ik naar een LED paal keek. Ik raakte in een soort van trance, werd rustiger en het licht nam mij mee. Het beeld werd soortvan groter dan waar ik bewust naar keek. Ook vond ik de soundscape en wat je zag goed bij elkaar passen.

English:

“I first went to sit and found it difficult to get into it, I had no idea what I was supposed to do exactly. Then I went to lie down and had the feeling that it was easier to follow the poles, Sven said that I could lie or sit but I noticed that when lying down those poles kind of appeared bigger and I did like that feeling, that I was really 'in it'. At first I kept looking at one specific LED pole and moved my head back and forth a lot to see every pole seperately, but after a while it seemed as if I saw the whole while I was looking at one LED pole. I ended up in a kind of trance, became calmer and the light took me along. The view became kind of bigger than what I was consciously looking at. I also thought that the soundscape and what you saw fit well together.”

8.3 Participant 3

(Participant experienced the installation sitting for approximately 30 minutes.)

Dutch:

“Ik vond het heel indrukwekkend, heel gaaf wat er gebeurde met die lichten en soms die pulserende rode kleur. Het voelde allemaal heel organisch, ik merkte al vrij snel dat ik er maar naar bleef kijken en het ging volgen. Ik werd omringd door die hoge palen, en dat voelde veilig en knus ofzo? Ik had ook soms het gevoel dat het geluidseffect precies overeenkwam met wat er op dat moment gebeurde met het licht. Ik lag gewoon stil en te kijken en toen op geven moment ging ik ook nadenken over mezelf, en dat ik goed bezig was en dat ik nog een reis wil maken buiten Europa. Ik kwam net uit werk dus had nog een druk hoofd, maar toen Sven de kamer binnenkwam en toen opstond was ik echt wel ff zen.”

English:

“I found it very impressive, very cool what happened with those lights and sometimes that they are pulsing red color. It all felt very organic, I noticed fairly quickly that I just kept looking at it and kept following it. I was surrounded by those tall poles, and that felt safe and cozy or something? I also sometimes had the feeling that the sound effect exactly corresponded with what was happening with the light at that moment. I was just lying still and looking and then at some moment I also started thinking about myself, and that I am doing well and that I still want to make a trip outside Europe. I had just come from work so I still had a busy head, but when Sven came into the room and then I stood up I was really quite zen for a moment.”

8.4 Participant 4

(Participant experienced the installation sitting for approximately 40 minutes.)

Dutch:

”Ik kwam net uit een lange dag met veel verschillende afspraken. Op het moment dat ik in Noctiluca plaats nam, probeerde ik mijn focus volledig op de lichtinstallatie en de ambient muziek te leggen. Toch merkte ik dat ik in het begin nog heel erg afdwaalde met mijn gedachten. Het was moeilijk om er direct in te stappen, maar naarmate ik langer zat werden mijn gedachtes afdwalingen steeds minder. Ik voelde op een gegeven moment dat ik steeds meer in het moment kwam en puur alleen aandacht had voor de lichtinstallatie. Het grappige is dat ik verbanden probeerde te leggen tussen het bewegen van het licht en het geluid, en analytisch begon te kijken of er bepaalde patronen in het bewegen van het licht te herkennen waren. Op visueel gebied zag ik op een gegeven moment de achtergrond niet meer zo duidelijk. De lichtpalen blurden als het ware tot één geheel, waarbij ik het volledige ‘breedbeeld’ kon zien terwijl ik toch naar één punt bleef kijken. Ik weet niet precies hoe ik dit moet verwoorden, maar als je dan weer een paar keer knipperde of je ogen op een andere plek liet rusten, zag je die palen er ineens weer in. Als ik kijk naar hoe ik mij voelde aan het begin en eind, zit het grootste verschil hem in het volledig tot rust komen van mijn gedachten. Op het eind was ik echt enkel bezig met de installatie en liet ik mijzelf niet meer wegdwalen in mijn hoofd.”

English:

”I had just come out of a long day with many different appointments. At the moment that I took a seat in Noctiluca, I tried to put my focus completely on the light installation and the ambient music. Still I noticed that in the beginning I still very much wandered off with my thoughts. It was difficult to step into it directly, but as I sat longer my thought wanderings became less and less. At a certain moment I felt that I came more and more into the moment and purely only had attention for the light installation. The funny thing is that I tried to make connections between the moving of the light and the sound, and I started to look analytically whether certain patterns in the moving of the light were recognizable. In the visual area I at a certain moment did not see the background so clearly anymore. The light poles blurred as it were into one whole,

whereby I could see the complete ‘widescreen’ while I still kept looking at one point. I do not know exactly how I must put this into words, but if you then blinked a few times again or let your eyes rest on another place, you suddenly saw those poles in it again.”

References

- [Agrawal and Bech, 2023] Agrawal, S. R. and Bech, S. (2023). *Immersion in Audiovisual Experiences*, pages 319–351. Springer International Publishing, Cham.
- [Avant, 1965] Avant, L. L. (1965). Vision in the ganzfeld. *Psychological Bulletin*, 64(4):246.
- [Csikszentmihalyi et al., 2014] Csikszentmihalyi, M. et al. (2014). *The collected works of Mihaly Csikszentmihalyi*. Springer.
- [Fan and Jin, 2014] Fan, M. and Jin, Y. (2014). Obesity and self-control: Food consumption, physical activity, and weight-loss intention. *Applied Economic Perspectives and Policy*, 36(1):125–145.
- [Farb et al., 2007] Farb, N. A. S., Segal, Z. V., Mayberg, H., Bean, J., McKeon, D., Fatima, Z., and Anderson, A. K. (2007). Attending to the present: mindfulness meditation reveals distinct neural modes of self-reference. *Social Cognitive and Affective Neuroscience*, 2(4):313–322.
- [Forkosh and Drake, 2017] Forkosh, J. and Drake, J. E. (2017). Coloring versus drawing: Effects of cognitive demand on mood repair, flow, and enjoyment. *Art Therapy*, 34(2):75–82.
- [Gibson, 1979] Gibson, J. J. (1979). The ecological approach to visual perception. .
- [Grill-Spector et al., 2006] Grill-Spector, K., Henson, R., and Martin, A. (2006). Repetition and the brain: neural models of stimulus-specific effects. *Trends in cognitive sciences*, 10(1):14–23.
- [Hare et al., 2009] Hare, T. A., Camerer, C. F., and Rangel, A. (2009). Self-control in decision-making involves modulation of the vmPFC valuation system. *Science*, 324(5927):646–648.
- [Kaplan et al., 1989] Kaplan, R., Kaplan, S., and Brown, T. (1989). Environmental preference: A comparison of four domains of predictors. *Environment and behavior*, 21(5):509–530.
- [Kaplan, 1995] Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of environmental psychology*, 15(3):169–182.
- [Keltner and Haidt, 2003] Keltner, D. and Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition and emotion*, 17(2):297–314.
- [Lee, 2004] Lee, K. M. (2004). Presence, explicated. *Communication theory*, 14(1):27–50.
- [Lombard et al., 2009] Lombard, M., Ditton, T. B., and Weinstein, L. (2009). Measuring presence: the temple presence inventory. In *Proceedings of the 12th annual international workshop on presence*, pages 1–15. University College London.

- [Piff et al., 2015] Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., and Keltner, D. (2015). Awe, the small self, and prosocial behavior. *Journal of Personality and Social Psychology*, 108(6):883–899.
- [Reber et al., 2004] Reber, R., Schwarz, N., and Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver’s processing experience? *Personality and social psychology review*, 8(4):364–382.
- [Roche and McConkey, 1990] Roche, S. M. and McConkey, K. M. (1990). Absorption: Nature, assessment, and correlates. *Journal of personality and social psychology*, 59(1):91.
- [Silvia and Duval, 2001] Silvia, P. J. and Duval, T. S. (2001). Objective self-awareness theory: Recent progress and enduring problems. *Personality and social psychology review*, 5(3):230–241.
- [Smalley and White, 2023] Smalley, A. J. and White, M. P. (2023). Beyond blue-sky thinking: Diurnal patterns and ephemeral meteorological phenomena impact appraisals of beauty, awe, and value in urban and natural landscapes. *Journal of Environmental Psychology*, 86:101955.
- [Smallwood and Schooler, 2013] Smallwood, J. and Schooler, J. W. (2013). The restless mind.
- [Staats, 2012] Staats, H. (2012). 24 restorative environments. *The Oxford handbook of environmental and conservation psychology*, page 445.
- [Styles, 2006] Styles, E. (2006). *The psychology of attention*. Psychology Press.
- [Taylor et al., 1999] Taylor, R. P., Micolich, A. P., and Jonas, D. (1999). Fractal analysis of pollock’s drip paintings. *Nature*, 399(6735):422–422.
- [Taylor et al., 2005] Taylor, R. P., Spehar, B., Wise, J., Clifford, C., Newell, B., and Martin, T. (2005). Perceptual and physiological responses to the visual complexity of pollock’s dripped fractal patterns. *Journal of Non-linear Dynamics, Psychology and Life Sciences*.
- [Van de Cruys and Wagemans, 2011] Van de Cruys, S. and Wagemans, J. (2011). Putting reward in art: A tentative prediction error account of visual art. *i-Perception*, 2(9):1035–1062.
- [Vohs et al., 2008] Vohs, K. D., Baumeister, R. F., Schmeichel, B. J., Twenge, J. M., Nelson, N. M., and Tice, D. M. (2008). Personality processes and individual differences-making choices impairs subsequent self-control: A limited-resource account of decision making self-regulation, and active initiative. *Journal of Personality and Social Psychology*, 94(5):883.
- [Yaden et al., 2019] Yaden, D. B., Kaufman, S. B., Hyde, E., Chirico, A., Gaggioli, A., Zhang, J. W., and Keltner, D. (2019). The development of the awe experience scale (awe-s): A multifactorial measure for a complex emotion. *The journal of positive psychology*, 14(4):474–488.