Enhancing Wellbeing in Public Landscape Through Light as Mood Booster

Ruiqing Miao, Landscape Architecture, RISD
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>06</td>
</tr>
<tr>
<td>Abstract</td>
<td>07</td>
</tr>
<tr>
<td>1 Sensory Perception x Wellness</td>
<td></td>
</tr>
<tr>
<td>Precedent 1: Central Park</td>
<td>12</td>
</tr>
<tr>
<td>Precedent 2: Diana Memorial</td>
<td>13</td>
</tr>
<tr>
<td>Conclusion</td>
<td>14</td>
</tr>
<tr>
<td>2 Light Perception x Seasonal Affective Disorder</td>
<td></td>
</tr>
<tr>
<td>A Reflection on My Winter Life</td>
<td>18</td>
</tr>
<tr>
<td>Seasonal Affective Disorder in Northeast U.S.</td>
<td>20</td>
</tr>
<tr>
<td>Traditional Treatment</td>
<td>21</td>
</tr>
<tr>
<td>3 Blue Light x Circadian Rhythm</td>
<td></td>
</tr>
<tr>
<td>Impact on Circadian Rhythm</td>
<td>24</td>
</tr>
<tr>
<td>The Process of Blue Light</td>
<td>25</td>
</tr>
<tr>
<td>Precedent 3: Gropius House</td>
<td>27</td>
</tr>
<tr>
<td>Light Exposure in Morning</td>
<td>28</td>
</tr>
<tr>
<td>Light Exposure during Daytime</td>
<td>30</td>
</tr>
<tr>
<td>Natural Blue Light</td>
<td>32</td>
</tr>
<tr>
<td>Artificial Blue Light</td>
<td>33</td>
</tr>
<tr>
<td>4 Proposal: SAD Treatment in Landscape</td>
<td></td>
</tr>
<tr>
<td>Implication &amp; Assumption</td>
<td>36</td>
</tr>
<tr>
<td>Before 4pm: Reflection &amp; Refraction of Natural Blue Light</td>
<td>37</td>
</tr>
<tr>
<td>4-7pm: Blue Lighting</td>
<td>38</td>
</tr>
<tr>
<td>After 7pm: Orange Lighting</td>
<td>39</td>
</tr>
<tr>
<td>5 Site: Downtown Providence</td>
<td></td>
</tr>
<tr>
<td>Where is Light?</td>
<td>42</td>
</tr>
<tr>
<td>Scale 1: Street Scale &amp; Lack of Light in Winter</td>
<td>44</td>
</tr>
<tr>
<td>Scale 2: Open Space Scale &amp; The Light Corridor</td>
<td>45</td>
</tr>
<tr>
<td>Light Study: The Surviving Triangle of Light in Winter</td>
<td>46</td>
</tr>
<tr>
<td>6 Project: A Late Afternoon Walk</td>
<td></td>
</tr>
<tr>
<td>Important Light Corridor + View</td>
<td>50</td>
</tr>
<tr>
<td>Reflection Puddles</td>
<td>52</td>
</tr>
<tr>
<td>Refraction Pavilions</td>
<td>54</td>
</tr>
<tr>
<td>Tree Array</td>
<td>56</td>
</tr>
<tr>
<td>Personal Reflection</td>
<td>58</td>
</tr>
<tr>
<td>Bibliography</td>
<td>59</td>
</tr>
</tbody>
</table>
INTRODUCTION

Vision is the most dominant sense and strongly impacts how people perceive space - physically, emotionally, and spiritually. The ephemeral qualities of light - brightness, color, texture - create various psychological and physiological effects.

Better for sight, better for eyes, better for health, and better for moods, natural light is understandably the majority’s favored method of illumination. People get vitamin D through natural light. It helps release serotonin. However, it’s an uncontrollable resource. When those cold winter nights draw in, the majority of our time is spent fumbling around in the dark.

Sunlight exposure plays a crucial role in regulating various physiological processes, including cognitive and behavioral functions. Reduced sunlight exposure can lead to vitamin D deficiency, disrupted circadian rhythm, and mood disorders, which can impact an individual’s overall health and well-being. Therefore, it is important to ensure adequate sunlight exposure by spending time outdoors, especially during the daytime.

My thesis starts with a broad concept regarding the relationship between receiving landscape and mental wellbeing, finding that it is the sensory perception that works in the process. Further related to my personal life experience in downtown Providence, I found that the amount of light that I got in winter is important to my mental health. By studying the causes and traditional treatments of Seasonal Affective Disorder, my proposal is that landscape provides a better treatment or prevention for SAD, enhancing mental wellbeing in winter.

I am intended to study a combination of various light forms: natural light, mechanical light, etc, and how seasonal change informs the nature of the interventions. It will focus on an actual site selected - downtown Providence - where I live and there will already be an underlying baseline of light conditions, seasonality, microclimate, etc, into which new scenarios can be created which in turn create a dialogue between my work and the existing site.

ABSTRACT

Close to half of Americans living in the U.S. Northeast and Midwest say they do not get enough sunshine throughout the year. That’s compared to less than a third of those living in the South or the West.

During the winter months, the days are shorter, with the sun rising later and setting earlier than during the summer months. This means there is less daylight for people to enjoy, and the reduced exposure to natural light can have a negative impact on mood and energy levels.

Public Health’s research demonstrates that constant stimuli of body senses plays an important role in regulating mood and energy levels. Exposure of the eye and skin to natural light in landscape stimulates our senses in an important way. To combat the lack of sunlight during the winter months, many people in the Northeastern area use artificial light sources such as light therapy lamps or light boxes to help improve their mood and energy levels.

My thesis seeks to engage light in public landscape to boost mood and energy levels in winter, as well as all year around. By catching natural light and amplifying light to be perceived especially in winter, other body senses would be triggered at the same time, thus enhancing wellbeing.


Chapter 1:
Sensory Perception
x
Wellness
What is WELLNESS?
Public Health authorities have officially acknowledged Central Park as a catalyst for promoting mental well-being.

Central Park is known to have positive effects on mental health due to its natural environment, green spaces, and recreational opportunities. Being in nature and engaging in activities like walking or exercising can reduce stress and improve mood. The park also offers a chance for social interaction and serves as an escape from the busy city environment.¹


Precedent 1: Central Park

Park = Catalyst for Mental Health

Figure 1. Photography of Central Park // Tetra Images / Getty Images

Precedent 2: Diana Memorial

Water + Textures = Senses + Moods

People come to the landscape with different moods.

People will correspond their current mood to the water texture in Diana memorial landscape.

Looking at water texture that represents their moods help to release that kind of mood, which facilitates mental emotional health.

Also, people are invited to different water textures related to other moods.

Figure 2. Diana, Princess of Wales Memorial Fountain, Hyde Park London // Jason Hawkes
Conclusion
Sensory Perception: Body Senses x Constant

Constant stimuli of body senses can play an important role in maintaining good mental health for several reasons:

Regulating Emotions: Sensory input can have a powerful impact on our emotional state, and by maintaining a consistent level of sensory input, we can regulate our emotions more effectively. For example, exposure to natural light, fresh air, and comfortable temperatures can help to regulate our circadian rhythms and reduce stress, while exposure to loud or chaotic environments can increase anxiety and stress levels.

Enhancing Awareness and Mindfulness: Sensory input can help us become more aware of our body and surroundings, which in turn can promote mindfulness and reduce stress. Being mindful of our body sensations and surroundings can also help us become more attuned to our own needs, which can help us make better decisions and feel more in control of our lives.

Providing a Sense of Comfort and Safety: Sensory input can also provide a sense of comfort and safety, which is essential for good mental health. For example, certain textures, scents, and sounds can trigger positive memories and associations, which can help us feel more relaxed and at ease. This is particularly important for people who have experienced trauma or have anxiety disorders.

Improving Cognitive Function: Sensory input can also have a direct impact on cognitive function. For example, exposure to natural light can improve cognitive performance and reduce symptoms of depression, while exposure to certain sounds can improve focus and concentration.¹

Overall, constant stimuli of body senses can help to regulate emotions, promote mindfulness, provide a sense of comfort and safety, and improve cognitive function, all of which can contribute to good mental health.


“The moving observer creates information in the environment. The senses do not work in isolation.”¹

- E Bruce Goldstein, and James R Brockmole, Sensation and Perception
Chapter 2:

Light Perception

x

Seasonal Affective Disorder
A Reflection On My Winter Life:

During the winter months, I feel super depressed, when I see the sun goes down early at 4pm...

4-5pm: Seeing the colorful light of an evening glow before the sky turns dark relieve my moods.

5-6pm: I sit in front of a light box, which helps to boost

How I go through the winter in downtown Providence?

During the winter months, I feel super down, when I see the leaves of trees all fall off...

7pm: The light reflected by fresh leaves and vegetables in the market exposes my eye to

7am: I build a refrigerator farm to bring those light to my home.
Seasonal Affective Disorder in Northeast U.S.

LIGHT in Northeast US.

\[
\frac{2}{3} \text{ LIGHT in South/West}
\]

+Winter: shorter days

\[\rightarrow \text{negative impact on mood and energy levels}\]

Seasonal Affective Disorder (SAD) is a type of depressive disorder characterized by recurring episodes of depression that typically occur during specific seasons, most commonly during the fall and winter months. It is believed to be influenced by changes in natural light exposure and the disruption of circadian rhythms, which are our body's internal biological clocks that regulate various physiological processes.¹

Close to half of Americans living in the U.S. Northeast and Midwest say they do not get enough sunshine throughout the year. That's compared to less than a third of those living in the South or the West. During the winter months, the days are shorter. This means there is less daylight for people to enjoy, and the reduced exposure to natural light can have a negative impact on mood and energy levels.²

Chapter 3:

Blue Light
x
Circadian Rhythm
Impact on Circadian Rhythms

Circadian rhythms are 24-hour biological cycles that regulate sleep-wake patterns, hormone secretion, body temperature, and other physiological functions. These rhythms are primarily influenced by environmental cues, particularly light exposure. The suprachiasmatic nucleus (SCN), a small region in the brain’s hypothalamus, acts as the central pacemaker for the circadian system.

In individuals with SAD, the reduced sunlight exposure during winter months can disrupt the normal functioning of the circadian system. The shorter and darker days can lead to a phase delay, where the internal clock is set later than usual. This delay can cause a misalignment between the internal clock and the desired sleep-wake schedule, resulting in symptoms such as excessive daytime sleepiness, fatigue, and difficulty concentrating.

Moreover, the disruption of circadian rhythms in individuals with SAD can impact the regulation of mood-related neurotransmitters, such as serotonin. Reduced sunlight exposure can lead to decreased serotonin levels, which are commonly associated with depression. The misalignment of circadian rhythms and alterations in neurotransmitter levels can contribute to the development and worsening of SAD symptoms.

Understanding the relationship between SAD and circadian rhythms is crucial for developing effective treatment strategies. Light therapy, a common treatment approach for SAD, aims to restore the disrupted circadian rhythms by providing exposure to bright light, typically in the morning. The bright light exposure helps to reset the internal clock and alleviate depressive symptoms.


The Process of Blue Light

In the case of SAD, the reduced daylight exposure during the fall and winter months can disrupt the circadian rhythm, leading to imbalances in the production of neurotransmitters like melatonin, serotonin, and cortisol.

Light enters the eye:
When light enters the eye, it passes through the cornea and the lens, which help focus the light onto the retina at the back of the eye.

Photoreceptors in the retina:
The retina contains specialized cells called photoreceptors, namely rods and cones, which are responsible for detecting light and converting it into electrical signals.

Melanopsin-containing retinal ganglion cells (mRGCs):
In addition to rods and cones, the retina also contains a specific type of photoreceptor called melanopsin-containing retinal ganglion cells (mRGCs). These cells are particularly sensitive to blue light and play a role in regulating the circadian rhythm and cortisol release.

Activation of mRGCs:
When light, especially blue light in the range of around 460-480 nanometers, stimulates the mRGCs, they become activated and send signals to the brain.
Optic nerve transmission:
The activated mRGCs transmit electrical signals via the optic nerve, which is a bundle of nerve fibers connecting the retina to the brain.

Suprachiasmatic nucleus (SCN):
The optic nerve carries the signals from the mRGCs to a small region in the brain called the suprachiasmatic nucleus (SCN). The SCN acts as the central pacemaker for the circadian rhythm.

Circadian rhythm regulation:
The SCN processes the information received from the mRGCs and sends signals to various parts of the brain and body to coordinate the circadian rhythm. This includes regulating the release of hormones, including cortisol.

Cortisol regulation:
The circadian rhythm, under the influence of the SCN, helps regulate the production and release of cortisol. Cortisol levels typically follow a diurnal pattern, with higher levels in the morning to help promote wakefulness and lower levels in the evening to facilitate sleep.

Feedback loop:
Cortisol, in turn, can also influence the circadian rhythm. Cortisol has the ability to modulate the sensitivity of the SCN to light, creating a feedback loop between cortisol and the circadian system.

Precedent 3:
Gropius House

In architectural design, strategic placement of windows and rooms can take advantage of natural light to positively impact circadian rhythms. One example of this approach is placing the bedroom on the west side, like in Gropius House in Boston, allowing the house owner to wake up with exposure to sunlight in the morning.

It also uses glass brick to catch and amplify the sunlight.
Light Exposure in Morning

1) Suppression of Melatonin:

Sunlight, especially in the morning, contains a significant amount of blue light. It plays a role in suppressing melatonin production, a hormone that promotes sleep, and promotes wakefulness and alertness. By receiving exposure to blue light in the morning, individuals may experience improved energy levels, mood, and overall well-being throughout the day.

2) Synthesis of Serotonin:

Studies have indicated that serotonin, a neurotransmitter associated with mood regulation, is synthesized in the brain from the amino acid tryptophan. Notably, light exposure, particularly in the morning, has been found to enhance the availability of tryptophan in the brain, subsequently leading to increased serotonin synthesis.

Multiple research studies have suggested that exposure to light, especially in the morning, can stimulate the release of serotonin in the brain. This release of serotonin is believed to have a positive impact on mood, promoting feelings of well-being, heightened alertness, and overall improved emotional state.

By increasing tryptophan availability and subsequent serotonin synthesis, morning light exposure can potentially offer therapeutic benefits for individuals experiencing mood disorders, such as Seasonal Affective Disorder (SAD) or depression.

3) Suppression of Cortisol:

Cortisol is often referred to as the “stress hormone” because its levels typically increase in response to stressors. However, cortisol also follows a diurnal pattern, with levels being highest in the morning and gradually decreasing throughout the day. This pattern is closely linked to the body’s circadian rhythm.

Exposure to natural light, especially in the morning, can help regulate cortisol levels and maintain a healthy circadian rhythm. Morning light exposure has been found to suppress the release of cortisol, allowing for a proper decline in cortisol levels as the day progresses. This regulation of cortisol helps support a balanced stress response and promotes optimal physiological functioning.

On the other hand, inadequate or irregular light exposure, particularly during the morning, can disrupt the cortisol rhythm. This disruption may lead to an abnormal cortisol pattern, such as elevated levels throughout the day or a blunted diurnal variation. Such disruptions can have implications for overall well-being, mood, and even sleep quality.


Light Exposure During Daytime

Light exposure has been shown to influence the regulation of dopamine, a neurotransmitter that plays a crucial role in various brain functions, including motivation, reward, and mood regulation.

Exposure to natural light, particularly bright light, has been found to increase dopamine release in the brain. This increase in dopamine levels is associated with enhanced mood, increased motivation, and improved cognitive function. Light exposure, especially in the morning, can help regulate dopamine levels and promote a sense of well-being and alertness throughout the day.

One of the mechanisms by which light affects dopamine regulation is through the activation of specialized retinal ganglion cells that are sensitive to light. These cells send signals to the brain’s reward centers, including the ventral tegmental area (VTA) and the nucleus accumbens (NAc)\(^1\), which are involved in dopamine release. Light-induced dopamine release can have a positive impact on mood and motivation, promoting feelings of happiness and reward.

In addition to its immediate effects, light exposure and the subsequent increase in dopamine levels can also have long-term implications for mental health. Insufficient exposure to natural light, especially in individuals who experience chronically low light levels, has been associated with conditions such as seasonal affective disorder (SAD) and depression, which are characterized by reduced dopamine activity.

---


---

Conclusion

In the case of SAD, the reduced blue light exposure during the fall and winter months can disrupt the circadian rhythm, leading to imbalances in the production of neurotransmitters like melatonin, serotonin, cortisol, and dopamine. On one hand, light exposure in the morning can suppress melatonin production that promotes sleep, promote the release of serotonin that has a positive impact on mood, and suppress the release of cortisol that helps support a balanced stress response. On the other hand, light exposure during daytime contributes to an increase of dopamine levels which enhances mood.
Natural Blue Light

Day time

Natural blue light is present in daylight when the sky appears blue. It is a product of sunlight scattering off molecules in the atmosphere. This natural blue light exposure during the day is important for regulating our circadian rhythm and promoting wakefulness and alertness.

Artificial Blue Light

Night time

On the other hand, artificial blue light can be found in various nighttime settings, such as restaurants or urban environments. It is emitted by artificial lighting sources, including LED lights and electronic devices. While artificial blue light at night can disrupt our circadian rhythm, hinder melatonin production, and potentially impact sleep quality, it can also have positive applications when used appropriately.
Chapter 4:

Proposal:
SAD Treatment in Landscape
Implication

Dr. Jonathan Schwartz, who specializes in the areas of Mood Disorders, confirmed that strolling outdoors soon after sunrise, even on a cloudy day, provides almost the same amount of light exposure as a light box. 1

Exposure of the eye and skin to natural light in landscape stimulates our senses and boost our moods in an important way. By reflecting and refracting natural light with blue light to be perceived especially in winter, it might help prevent or relieve symptoms of Seasonal Affective Disorder.

Assumption

During winter months, reflection and refraction of daylight might increase exposure of human eyes to blue light before sunset (4pm).

Artificial blue light might be used in landscape during 4-7pm to extend exposure of blue light.

It might help to regulate circadian rhythms in winter months and prevent or relieve symptoms of Seasonal Affective Disorder.

Before 4pm: Reflection & Refraction of Natural Blue Light

A Daytime Walk with Natural Blue Light

The sunset time during the winter months in Northeast U.S. is around 4pm. Before 4pm, the phenomenon of reflection daylight by puddles or pools can potentially result in increased exposure of human eyes to blue light. As a result, the blue light component becomes more prominent, and our eyes may experience heightened exposure to it during the late afternoon hours, despite the approaching sunset. This increased exposure to blue light before sunset during winter months may have implications for our circadian rhythm, mood levels and overall well-being.

1) Reflection Puddle

2) Refraction Pavilion

4-7pm:  
Blue Lighting

A Late Afternoon Walk with Artificial Blue Light

During the winter season, from 4pm to 7pm, when there should be daylight in other seasons, artificial blue light can be employed in parks to extend the exposure to blue light. By providing additional blue light during this time frame, it is believed that it may help mitigate the symptoms of Seasonal Affective Disorder (SAD) or even prevent their onset. The strategic use of artificial blue light in the park during these hours can potentially aid in maintaining a balanced circadian rhythm and promote a sense of well-being and mood stability during the winter season.

Figure 10. Blackstone Heritage Corridor Visitors Center // Landworks Studio

After 7 pm:  
Orange Lighting

An Evening Walk with Orange Lighting

After 7pm, the lighting in the park turns a warm orange color to help release melatonin for feeling sleepy naturally, promoting a more conducive environment for a healthy sleep pattern.

This dynamic lighting approach takes into account the impact of different light wavelengths on the circadian rhythm, aligning with the natural progression of the day and optimizing the bridge's lighting to support both wakefulness and restful sleep.

Figure 11. Providence Pedestrian Bridge // INFORM studio
Chapter 5:

Site:
Downtown Providence
Where is LIGHT?
In what SCALE?
Scale 1: Street Scale
- Lack of Light in Winter

At street scale, downtown Providence is covered by buildings. The combination of narrow streets and the lower winter sun causes all the streets to be enveloped in shadows. Plus the strong wind between buildings, it makes people feel cold and depressed.

Scale 2: Open Space Scale
- An Important Light Area

The open space is a transportation hub with light, transferring pedestrians coming from the pedestrian bridge to different directions of downtown Providence.
Light Study:
An Important Light Corridor
During Winter Months

The winter months in Providence is from December to March. The light-filled space that survives between buildings’ shadow changes over time.

During the winter months, from sunrise to sunset, there is always an important light corridor that survives.
Chapter 6:

Project:
A Late Afternoon Walk
Reflection Puddles

The puddles collect rain water and flow into the pond. The pond is connected to the river, and the water level changes with the ebb and flow of the river.

Before

After
Refraction Pavilions

The reflection pavilions are made of glass bricks, a material that catches and amplifies the sunlight.

As a transparent container of water collected, it refracts sunlight onto the ground, appearing as water ripples textures changing with winds.
Tree Array

At the entrance and intersection of the park, tree array are designed to highlight the entrance of park, indicating the direction of the paths.
Personal Reflection

From the outset, my interest was captivated by the intricate relationship between landscape and wellness. As I delved into extensive research, I discovered that this connection lies in the perpetual stimulation of our body's senses—our sensory perceptions.

Intriguingly, my personal experience during the winter in downtown Providence prompted a profound realization of the paramount significance of light perception. I discerned how light profoundly impacted my overall wellness and mental health.

Through an in-depth exploration of Seasonal Affective Disorder (SAD) and its association with circadian rhythms, particularly the effects of blue light in traditional treatments, I proposed that landscapes could potentially offer a more effective approach to treating or even preventing SAD. Within a park, individuals could be exposed to a copious amount of natural and artificial blue light, equivalent to what they would receive from a light box.

As I embarked on walks amidst the urban context of downtown Providence—my home for the past two years while studying at RISD—an important open space captured my attention. This space happened to align with a vital light corridor during the winter months and offered a remarkable view. Inspired by this discovery, I envisioned incorporating reflection puddles and refraction pavilions along the path. Such additions would enable pedestrians to immerse themselves in an abundance of light and enhance their sensory experience of light.

By harnessing the power of reflection and refraction to perceive winter light, this concept establishes a precedent for cities in the Northeastern U.S. where SAD affects a significant portion of the population. It provides a guide for these cities to prioritize light design in their landscapes, which contributes to alleviating the symptoms associated with SAD.

This thesis firmly reinforced my belief in the profound impact of sensory perception in landscape architecture on mental health. It further solidified my conviction that this symbiotic relationship will continue to be the essence of landscape architecture and its transformative potential.

Bibliography


