

2026.01.19

# Attention, please

Peripheral Vision, Distraction, and Lighting Technology in Low-Light  
Domestic Environments

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## Master Thesis Project

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# Abstract

Lighting design standards and practice primarily address visibility and task performance, often prioritising central vision while giving limited attention to how peripheral lighting conditions influence attention and distraction. This thesis investigates how variations in peripheral lighting affect perceived distraction, visual comfort, and focus during a visually demanding task in a low-light domestic environment, while considering individual differences in self-reported attentional tendencies. The study adopts an exploratory mixed-methods, research-through-design approach. Three lighting scenarios were developed that systematically varied peripheral illuminance, contrast, and spectral composition while maintaining a consistent task-focused activity. Data were collected through behavioural observation of gaze shifts, Likert-scale self-reports of focus, distraction, and comfort, and brief open-ended participant feedback. Eight participants took part in the study, representing a range of self-reported attentional experiences. The findings indicate that strong luminance contrast between task and peripheral areas tends to increase attentional monitoring and perceived distraction, even when task visibility is sufficient. Reduced-contrast peripheral lighting supported more stable attentional engagement and higher reported comfort across participants. A coloured peripheral lighting condition produced mixed responses, highlighting a trade-off between atmospheric qualities and attentional saliency. Participants with higher self-reported distractibility showed greater sensitivity to high-contrast peripheral stimuli, whereas reduced-contrast strategies led to more consistent experiences across users.

**Key words:** Peripheral vision; Peripheral lighting; Luminance contrast; Visual comfort; Distraction; Low-light (mesopic) environments; Inclusive design.

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# Introduction

Lighting is commonly understood as a technical means of ensuring visibility, safety, and task performance. Within both professional practice and regulatory frameworks, lighting quality is frequently evaluated through measurable parameters such as illuminance, uniformity, glare, and colour rendering. These criteria play a crucial role in establishing functional visual conditions and form the basis of widely applied lighting standards. However, lighting also shapes how environments are perceived, experienced, and attended to, influencing not only what is seen but how visual information is processed and prioritised.

In everyday domestic environments, lighting conditions often differ substantially from those assumed in workplace and public building standards. Low ambient illumination, accent lighting, and uneven luminance distributions are commonly used to create atmosphere, comfort, or intimacy, particularly during evening hours. At the same time, many domestic activities - such as reading, studying, puzzles, or screen-based tasks - require sustained visual attention. In these contexts, users must navigate a balance between atmospheric lighting and the need for focus, often under conditions where peripheral visual information becomes more prominent.

Human visual perception is not limited to the central field of view. While central (foveal) vision supports detailed, task-oriented processing, peripheral vision continuously monitors the surrounding environment and plays a critical role in orientation, motion detection, and attentional guidance. Peripheral vision is especially sensitive to luminance contrast and change, and its sensitivity increases under low-light conditions, when visual processing relies more heavily on rod-mediated pathways. As a result, lighting elements outside the direct focus of attention may shape attentional experience even when they are not consciously perceived.

# Background and Inspiration

When analysing the lighting standard EN 12464-1 and thinking about what is asked for in projects regarding lighting design the wishes for it always come down to laws, regulations and standards. Lighting projects for work spaces or specific spaces in the public sector rely on lighting calculations that can live up to what EN 12464-1 states. Having a focus on visibility, task performance and comfort are important to ensure that these spaces are functional from a basic visual standpoint but beyond that the focus on other things are considered less. This could be how lighting influences the individual process of analysing visual information and attending to their environments, especially in conditions with low light levels.

This thesis aims to explore how important cognitive and perceptual factors are in lighting design including the role of peripheral vision and susceptibility to distractions and how lighting is more than just a tool for seeing.

## Low-light vision: functional changes

Conditions with low-light introduce a significant change for human vision. In environments with light levels that are lower than a typical indoor space, but brighter than complete darkness, mesopic and scotopic environments, the human vision relies increasingly on rod-mediated photoreceptors because they are more sensitive to motion and contrast but also less capable of discerning fine details (Zele & Cao, 2015). Additionally, conditions with low-light affect contrast perception, spatial awareness, and depth perception which requires an increased use of peripheral visual information to navigate and interact within the space (Dresp-Langley, & Reeves, 2024). An increase in reliance on peripheral vision holds important implications for lighting design due to the primary focus on conventional standards regarding central vision tasks

## The role of peripheral vision

The area that encompasses peripheral vision is outside of the central visual field and is highly sensitive to motion and changes in luminance, even in low-light conditions. This is why peripheral vision plays a crucial role in spatial orientation, navigation, and awareness of environmental changes. This is what allows individuals to detect objects, movements or hazards without having to focus on it directly.

Research shows that stimuli in peripheral vision can affect attentional allocation, as reflected in pupillary responses and gaze patterns

Moreover, task performance can be interfered with by peripheral distractors, specifically in situations that are visually complex or are poorly lit (Vilotijević, & Mathôt, 2023). This points to the need to consider peripheral visual load for designers in low-lit environments where users depend more on non central cues.

## **Lighting, attention and distractions**

While lighting conditions not only affect vision they also have an influence on attention and susceptibility to distractions. Factors like uneven luminance, glare, flicker and bright peripheral sources can draw involuntary attention, reducing focus from primary tasks. In addition to this, low-light conditions increase the cognitive load which leads to a heightened sensitivity in individuals regarding multisensory distractions such as ambient sound or motion in the environment (Panagiotidi, et al, 2017). This means in practice that even subtle lighting design choices like placement of accent lights or reflective surfaces can have measurable effects on focus and comfort.

## **Attentional diversity and functional impact**

In lighting research it is often assumed that the user is an average person. This however does not take into account people with attentional differences which can significantly alter how a space is experienced. This can for example be seen in adults exhibiting ADHD-related traits which show increased distractibility and different visual search strategies, especially when peripheral stimuli are present (Panagiotidi, et al, 2017). While these differences are functional rather than clinical, it shows that the focus is on how environmental design can support or hinder attention and focus.

Creating a lighting design that has a focus on inclusivity towards differences in for example attention can have an improved effect on comfort and task performance in low-light environments (Kim, et al, 2014). This can for instance reduce distractions and enhance spatial orientation in spaces with uniform luminance distribution and the avoidance of unnecessary peripheral brightness.

## **Problem Analysis**

Contemporary lighting design practice is strongly influenced by technical standards and guidelines that aim to ensure visual comfort, safety, and task performance. One of the most widely applied frameworks in European contexts is EN 12464-1, which specifies requirements for lighting in indoor work environments, including parameters such as maintained illuminance, luminance distribution, glare limitation, colour rendering, and uniformity (Danish Standards Foundation, 2021). These standards play a crucial role in establishing baseline conditions for visual performance and preventing visual fatigue or discomfort.

However, such standards are primarily developed with a focus on task-oriented, foveal vision, emphasizing horizontal illuminance levels on work planes and limiting discomfort glare in relation to direct view of luminaires. While aspects such as luminance ratios and background brightness are acknowledged, they are typically treated as secondary conditions supporting central visual tasks rather than as primary experiential or attentional factors (Boyce, 2014). As a result, the peripheral visual field - which occupies the majority of human visual perception and plays a key role in spatial awareness, motion detection, and attentional guidance - is only indirectly addressed.

Research in vision science and cognitive psychology demonstrates that peripheral vision, despite its reduced spatial resolution and colour sensitivity, is highly sensitive to luminance contrasts, motion, and temporal changes (Dresp-Langley & Reeves 2024). These characteristics make the peripheral field particularly influential in involuntary attentional capture. High-contrast luminance elements, exposed

light sources, or localized brightness gradients outside the central field of view may therefore attract attention away from a focal task, even when overall illuminance levels comply with existing standards.

Importantly, current lighting standards do not explicitly address attentional distraction, attentional load, or individual differences in attentional regulation. The implicit assumption is that compliance with recommended illuminance, uniformity, and glare limits will automatically result in optimal visual and cognitive conditions. This assumption is increasingly questioned by interdisciplinary research suggesting that visual comfort does not necessarily equate to attentional stability, specifically within spaces with complex luminance distributions or low ambient light levels (Lavie, 2005).

The issue becomes especially relevant in low-light domestic environments, where lighting is often intentionally subdued for reasons of atmosphere, relaxation, or energy efficiency. Under these circumstances, users frequently engage in visually and cognitively demanding activities - such as reading, puzzles, or screen-based tasks - under lighting conditions that deviate significantly from those assumed in office-oriented standards. The contrast between a brightly lit task area and a dim or unevenly illuminated surrounding field may amplify peripheral saliency, increasing the likelihood of attentional shifts or perceived distraction.

Furthermore, lighting standards are designed to accommodate an “average” user and generally do not consider attentional diversity. Individuals differ in their sensitivity to sensory input, their ability to filter peripheral stimuli, and their susceptibility to distraction (Panagiotidi, et al, 201). While these differences are well documented in cognitive research, they remain largely absent from normative lighting frameworks. As a result, existing standards provide limited guidance for designing lighting environments that support sustained focus across a broader range of attentional profiles.

This gap suggests a need to complement standards-based lighting design with research that explicitly examines how peripheral luminance distribution influences perceived distraction, focus, and comfort - particularly in low-light, non-institutional settings. Addressing this gap does not seek to replace established standards, but rather to extend their applicability by introducing attentional and perceptual considerations that are currently underrepresented.

## **Delimitation of the Study**

In response to the identified problem area, this thesis deliberately narrows its scope in order to allow for a focused and methodologically feasible investigation.

First, the study is delimited to a domestic living room-like environment. Unlike office or educational settings, domestic spaces are characterized by greater variability in lighting conditions, fewer formal guidelines, and a stronger emphasis on atmosphere and personal preference. By focusing on a familiar, everyday context, the study aims to increase ecological validity while acknowledging that findings may not be directly transferable to highly regulated work environments.

Second, the investigation is limited to low-light conditions, reflecting lighting levels commonly used in evening or leisure scenarios rather than those prescribed for high-performance tasks. This delimitation is intentional, as low ambient illumination increases reliance on peripheral luminance cues and may intensify attentional sensitivity to contrast and spatial light distribution (Zele & Cao 2014). The study

does not aim to identify optimal illuminance values, but rather to explore how different lighting strategies shape subjective and behavioral responses within an already low-light context.

Third, the thesis adopts a non-clinical perspective on attentional diversity. While research on attention-deficit disorders provides valuable insights into mechanisms of distraction and sensory sensitivity, this study does not diagnose, classify, or compare clinical groups. Instead, attentional variability is treated as a spectrum of everyday human differences. This approach aligns with principles of inclusive design, focusing on environments that accommodate a wider range of perceptual and attentional needs without medical categorization.

Fourth, the experimental methodology is deliberately low-tech. Rather than employing eye-tracking systems or physiological measurements, the study relies on observable gaze behavior, self-reported focus and distraction ratings, and qualitative participant feedback. This choice reflects both practical constraints and a design-oriented research perspective, emphasizing methods that are accessible and replicable within lighting design practice. While this limits measurement precision, it allows the study to prioritize experiential insight and real-world applicability.

Through these delimitations, the thesis seeks to balance analytical depth with practical relevance. The intention is not to provide comprehensive or universal prescriptions, but to generate focused insights into how peripheral lighting conditions may influence attention and perceived distraction, thereby informing more inclusive and perceptually sensitive lighting design strategies.

## **Research Question**

Based on the identified limitations of existing lighting standards and the underexplored role of peripheral vision in attentional regulation, this thesis investigates how lighting design strategies influence perceived distraction and focus in low-light domestic environments. The study is grounded in theories of visual perception and attention, particularly the functional differences between central and peripheral vision, and is informed by inclusive design perspectives that recognize attentional variability among users. Rather than evaluating compliance with established illuminance standards, the research focuses on experiential and behavioral responses to different peripheral lighting conditions within an ecologically plausible setting. Through an exploratory experimental design combining observational and self-reported measures, the thesis seeks to examine how variations in peripheral luminance distribution affect attentional stability, visual comfort, and subjective focus during a visually demanding task. The following research questions guide the investigation:

***How do different peripheral lighting conditions shape perceived distraction and focus during a visually demanding task, considering variability in participants' self-reported attentional tendencies?***

# Literature review

## Vision and Visual Attention

### Central (Foveal) Vision

Central vision, also referred to as foveal vision, is responsible for high-acuity visual perception and is primarily mediated by cone photoreceptors densely concentrated in the fovea of the retina. This region enables precise spatial resolution, fine detail discrimination, and colour perception, making it essential for tasks such as reading, writing, and detailed object recognition (Zele & Cao 2014).

Due to its high spatial and chromatic sensitivity, central vision plays a dominant role in task-oriented visual activities. Visual information processed in the fovea supports focused attention and conscious analysis, allowing individuals to engage in activities that require sustained concentration and accuracy. As a result, many lighting standards and design practices implicitly prioritise foveal vision by emphasising horizontal illuminance levels, uniformity on task surfaces, and glare control within the central field of view (Boyce, 2014). However, central vision covers only a small portion of the overall visual field. While it excels in detail-oriented perception, it provides limited awareness of the broader environment. This means that lighting strategies based solely on optimising foveal task performance may overlook how users experience and respond to the surrounding space, particularly in low-light environments where visual processing shifts away from cone-dominated vision (Zele & Cao, 2015).

In the context of lighting design, this highlights a structural bias toward task-centric illumination, where success is measured primarily through visibility and performance metrics associated with central vision. While these criteria are essential, they represent only one aspect of human visual perception and do not fully account for how lighting conditions influence attention, orientation, and comfort at a perceptual and cognitive level.

### Peripheral Vision

Peripheral vision encompasses the regions of the visual field outside the fovea and is characterised by lower spatial resolution, reduced colour sensitivity, and increased reliance on rod photoreceptors. Unlike central vision, peripheral vision is not optimised for detailed analysis but instead functions as a system for monitoring the broader environment (Strasburger et al. 2011).

Despite its reduced acuity, peripheral vision exhibits heightened sensitivity to motion, luminance changes, and contrast variations. These properties make it particularly effective at detecting environmental changes and guiding attention toward potentially relevant stimuli. In low-light conditions, where cone-mediated vision becomes less effective, peripheral vision plays an increasingly important role in spatial orientation and navigation, as rod photoreceptors are more sensitive to low luminance levels (Zele & Cao, 2015). Peripheral vision operates largely outside of conscious awareness and continuously scans the environment for salient events. This function allows individuals to maintain orientation and respond to changes without actively directing gaze toward them. However, this same mechanism also makes peripheral vision susceptible to distraction, as abrupt luminance contrasts, glare, or movement in the peripheral field can involuntarily capture attention .

From a lighting design perspective, peripheral vision is critical in shaping how a space is experienced beyond task performance. Uneven luminance distributions, bright peripheral light sources, or high-contrast transitions can increase perceptual load and disrupt attentional stability, particularly in low-light environments where users depend more heavily on peripheral cues (Dresp-Langley & Reeves, 2024). Despite this, peripheral vision remains underrepresented in lighting guidelines, which tend to focus on central task areas rather than the perceptual qualities of the surrounding visual field. Recognising the functional role of peripheral vision highlights the need for lighting strategies that consider not only what users look at directly, but also what they perceive indirectly. This broader understanding is essential for creating environments that support comfort, orientation, and sustained focus, particularly in contexts where lighting conditions deviate from standard indoor illumination levels.

## **Peripheral Vision and Distraction**

Peripheral vision plays a central role in how attention is allocated within an environment, particularly through mechanisms of involuntary attentional capture. Unlike central vision, which is largely under voluntary control and directed toward task-relevant stimuli, peripheral vision continuously monitors the surroundings for salient changes that may require a shift in attention (Carrasco, 2011). This process operates largely outside conscious awareness and is strongly influenced by stimulus properties such as contrast, luminance, motion, and temporal change.

Attentional capture theory describes how certain visual stimuli automatically attract attention regardless of the observer's intentions. Salient features, including abrupt luminance transitions, high contrast edges, and movement, are particularly effective at capturing attention when they appear in the peripheral visual field (Carrasco, 2011). From a perceptual standpoint, this mechanism is adaptive, as it allows for rapid detection of potential threats or changes in the environment. However, in designed environments, the same mechanism can become a source of distraction, interfering with focused tasks.

Research has shown that peripheral distractors can significantly impair task performance by triggering involuntary attentional shifts and increasing cognitive load. It has been demonstrated that visual stimuli presented in the peripheral field can disrupt decision-making and task execution, particularly under conditions of increased mental demand. This effect is further amplified in visually complex environments, where multiple competing stimuli increase perceptual load and reduce attentional stability. The concept of visual saliency is closely linked to peripheral distraction. Saliency refers to the degree to which a stimulus stands out from its surroundings due to differences in luminance, colour, contrast, or motion. In lighting design, uneven luminance distributions, bright peripheral light sources, reflective surfaces, or dynamic lighting elements can unintentionally create highly salient stimuli in the peripheral field. These stimuli may repeatedly draw attention away from central tasks, even when they are not functionally relevant (Itti & Koch, 2001).

Low-light environments introduce additional complexity to attentional processes. Under mesopic and scotopic conditions, visual perception relies more heavily on rod-mediated pathways, which are particularly sensitive to contrast and motion but less capable of resolving fine detail (Zele & Cao, 2015). As a result, peripheral vision becomes more dominant, and the visual system is more responsive to changes in luminance and movement. This heightened sensitivity increases the likelihood that peripheral lighting elements will capture attention, thereby intensifying susceptibility to distraction.

In practical terms, this means that lighting characteristics that may be acceptable or even beneficial under typical indoor illumination levels can become disruptive in low-light conditions. Bright accent lights, sharp luminance gradients, or exposed light sources located outside the central field of view can create unintended attentional demands. These effects are not necessarily perceived as consciously distracting, but they can nonetheless reduce perceived comfort and sustained focus by continuously engaging attentional resources (Lavie, 2005).

Colour perception has been shown to influence attentional and affective processes, particularly when colour is perceived outside the primary focus of attention. In their comprehensive review of colour psychology, Elliot and Maier (2014) argue that red is consistently associated with heightened arousal and increased attentional saliency. Red stimuli are more likely to capture attention automatically, even when they are not directly task-relevant, due to both learned associations and physiological responses linked to arousal. Importantly, the attentional effects of red are not limited to focal perception. Highly saturated or bright red elements in the visual environment may act as salient peripheral cues, increasing the likelihood of involuntary attentional shifts. Within a lighting context, this suggests that red ambient or peripheral illumination may introduce additional attentional demands, particularly in low-light environments where colour contrasts become more pronounced against dark surroundings. While red light is often used intentionally to create atmosphere or warmth in domestic settings, its potential to function as a salient peripheral stimulus raises questions about its suitability in environments that require sustained focus. Rather than being inherently disruptive, red peripheral lighting may therefore need to be carefully calibrated in terms of brightness, saturation, and spatial placement to avoid unintended attentional capture.

Despite these findings, peripheral distraction remains underrepresented in lighting design standards and guidelines, which primarily address glare, uniformity, and illuminance within task areas. While these parameters are essential for ensuring visual performance, they do not fully account for how lighting influences attentional dynamics across the entire visual field. Integrating insights from attention research into lighting design therefore represents an important step toward creating environments that support both functional performance and cognitive comfort.

## **Lighting Design and Visual Comfort**

Visual comfort is a central objective in lighting design and is commonly addressed through parameters such as illuminance, luminance distribution, uniformity, and glare control. These parameters are embedded in lighting standards, including EN 12464-1, which aim to ensure that visual environments support task performance and minimise discomfort. While such standards provide an essential baseline for functional lighting design, they primarily focus on central vision and task-oriented criteria, often overlooking how lighting conditions affect perceptual and attentional processes across the broader visual field (Boyce, 2014).

One of the key considerations in visual comfort is the balance between uniformity and contrast. Uniform lighting distributions are generally associated with reduced visual strain and ease of adaptation, particularly for tasks requiring sustained attention. However, complete uniformity is neither achievable nor desirable in most environments, as some degree of contrast is necessary for spatial perception, orientation, and visual interest (Cuttle, 2015). The challenge for lighting design therefore lies in managing

contrast in a way that supports perception without introducing unnecessary visual noise, particularly in peripheral areas of the visual field. Glare represents another critical factor influencing visual comfort and attentional stability. Discomfort glare refers to subjective sensations of annoyance or visual fatigue caused by bright light sources, while disability glare directly impairs visibility by reducing contrast sensitivity (Boyce, 2014). Both forms of glare are strongly influenced by the position of light sources relative to the observer's line of sight, making peripheral glare a particularly relevant concern. Light sources located outside the central field of view may not interfere directly with task visibility, yet they can still trigger attentional capture and reduce perceived comfort, especially in low-light environments where luminance differences are more pronounced.

Visual adaptation and brightness transitions further shape the experience of comfort within a space. The human visual system continuously adapts to prevailing luminance levels, but rapid or extreme luminance changes can disrupt this process and increase perceptual effort. In environments with uneven luminance distributions, frequent shifts between bright and dark zones may place additional demands on both visual and cognitive resources. This effect is amplified under mesopic conditions, where adaptation processes are slower and peripheral sensitivity to luminance changes is heightened (Zele & Cao, 2015).

Research on activity-focused lighting consistently demonstrates that task performance and subjective focus are influenced not only by illuminance levels but also by the spatial distribution of light within the visual environment. In a field simulation study, Boyce et al. (2006) found that lighting conditions perceived as supportive of work were characterised by balanced luminance distributions and reduced visual distraction, rather than by higher illuminance alone. Participants in the study reported greater satisfaction and perceived task support in environments where lighting provided clear task visibility while maintaining visual coherence across the surrounding field. Excessive contrast, glare, or visually dominant elements outside the task area were associated with reduced comfort and increased awareness of the environment, even when performance measures remained unaffected. These findings suggest that activity-focused lighting should be understood as a balance between task clarity and environmental calmness. Within low-light domestic settings, this balance becomes particularly relevant, as strong central illumination combined with dark surroundings may unintentionally increase peripheral saliency and attentional demands. Activity-focused lighting strategies that consider peripheral luminance may therefore better support sustained focus without relying on high overall brightness.

Despite the importance of these perceptual mechanisms, lighting standards tend to address visual comfort primarily through quantifiable metrics applied to task areas, such as minimum illuminance levels and glare indices. While these metrics are effective for ensuring baseline visibility, they do not fully account for how users perceive and respond to lighting conditions beyond the central task zone. In particular, the influence of peripheral luminance, contrast gradients, and spatial brightness hierarchies on attention and comfort remains insufficiently addressed in normative guidelines.

From a design perspective, this highlights the need to move beyond a purely task-centric understanding of visual comfort toward a more holistic approach that considers the entire visual field. By integrating insights from perception and attention research, lighting design can better account for how luminance distributions, light placement, and contrast relationships influence not only visibility but also cognitive comfort and attentional stability. This approach is especially relevant in low-light environments, where small design decisions can have disproportionately large perceptual effects.

## **Inclusive Design and Attention Diversity**

Inclusive design is an approach that aims to accommodate the widest possible range of users by recognising human variability rather than designing for an assumed “average” user. Within environmental and architectural design, inclusive principles emphasise flexibility, adaptability, and responsiveness to diverse sensory, cognitive, and perceptual needs (Clarkson et al., 2013). In the context of lighting design, this perspective highlights the importance of considering how different users may perceive and respond to the same lighting conditions in markedly different ways.

Traditional lighting research and standards often rely on normative assumptions about visual performance and comfort, focusing on statistically averaged responses to lighting parameters such as illuminance and glare. While this approach is effective for establishing baseline requirements, it tends to overlook individual differences in attention, sensory sensitivity, and perceptual processing. As a result, lighting environments that meet technical standards may still be experienced as distracting or uncomfortable by certain users. Attention diversity refers to natural variations in how individuals allocate, sustain, and shift attention within their environments. One example of such variation can be observed in individuals who exhibit ADHD-related traits, including increased distractibility, heightened sensitivity to environmental stimuli, and differences in visual search strategies (Panagiotidi et al. 2017). Importantly, these differences are functional rather than clinical within the scope of this thesis and are considered here as part of a broader spectrum of attentional variability present in the general population.

Research indicates that individuals with higher susceptibility to distraction are more affected by peripheral stimuli, particularly in visually complex or low-light environments. It was found that peripheral visual input can disproportionately interfere with task performance under conditions of increased cognitive load (Panagiotidi et al. 2017). This suggests that lighting features such as bright peripheral sources, sharp luminance contrasts, or uncontrolled reflections may have unequal effects across users, amplifying attentional strain for those who are more sensitive to environmental stimuli. Several studies indicate that white light with higher correlated colour temperatures may support alertness and attentional engagement, particularly during cognitively demanding tasks. Küller et al. (2006) found that cooler and more neutral white lighting conditions were associated with increased perceived activation and reduced subjective fatigue compared to warmer lighting environments. These effects were observed independently of illuminance, suggesting that spectral composition contributes to cognitive experience. Research focusing on attentional performance suggests that increased alertness associated with brighter or cooler white lighting conditions may be particularly relevant in tasks requiring sustained attention. Studies of indoor lighting environments indicate that cooler and more neutral white light can support perceived activation and reduce subjective fatigue independently of illuminance (Küller et al., 2006). While such findings do not imply universal effects, they suggest that lighting conditions may interact with individual differences in attentional sensitivity.

From an inclusive lighting design perspective, addressing attention diversity does not require tailoring environments to specific diagnoses. Instead, it involves identifying lighting strategies that reduce unnecessary perceptual and cognitive demands for all users. Design approaches that promote balanced luminance distributions, minimise peripheral glare, and avoid abrupt luminance transitions can support attentional stability and comfort across a wider range of users (Clarkson et al., 2013). Such strategies are particularly relevant in low-light environments, where increased reliance on peripheral vision can exacerbate attentional challenges. By integrating attention diversity into lighting design considerations,

designers can move beyond minimum compliance toward environments that actively support cognitive comfort and sustained focus. This approach aligns with inclusive design principles by acknowledging variability as a fundamental design condition rather than an exception. In doing so, lighting design can contribute not only to visual performance but also to broader goals of accessibility, wellbeing, and user-centred environmental quality.

## Research Gap

Existing research within vision science has established that peripheral vision plays a central role in attentional capture, spatial orientation, and the detection of luminance and motion changes. Numerous experimental studies demonstrate that high-contrast or salient stimuli in the peripheral visual field can involuntarily draw attention away from central tasks, particularly under conditions of increased cognitive load or reduced visual clarity. These effects have been examined primarily through laboratory-based paradigms using controlled visual stimuli, eye-tracking, and reaction-time measures. In parallel, lighting research has explored visual comfort, glare, luminance distribution, and adaptation processes, often with the goal of optimizing visual performance and minimizing discomfort. Studies in this domain frequently evaluate the effects of uniformity, brightness ratios, and glare sources on perceived comfort and task efficiency. However, these investigations tend to prioritize central vision tasks and frontal viewing conditions, while peripheral vision is typically considered only indirectly, such as in discussions of glare or visual noise.

A limited number of studies bridge these domains by examining how environmental lighting conditions influence attention and distraction. For example, research on visual saliency and environmental complexity suggests that uneven luminance distributions and bright peripheral elements can increase attentional instability. Nevertheless, such findings are rarely translated into concrete lighting design strategies, and few studies investigate how peripheral lighting conditions specifically affect perceived distraction in everyday environments. Moreover, most empirical work in this area is conducted in highly controlled or technologically advanced settings, such as laboratories or simulated workspaces. There is a lack of research focusing on domestic or low-tech environments, where lighting is often more heterogeneous and less strictly regulated, yet where sustained attention is frequently required. As a result, the relevance of perceptual findings to real-world lighting design practice remains underexplored. Finally, while inclusive design literature emphasizes designing for user variability rather than an assumed average, attentional diversity is seldom addressed within lighting design research. Although studies in cognitive psychology show that individuals differ in susceptibility to distraction - particularly in response to peripheral stimuli - these differences are rarely considered in lighting guidelines or design methodologies.

In response to these gaps, this thesis investigates how lighting conditions in the peripheral visual field influence distraction, visual comfort, and perceived focus in a low-light, domestic context. By combining perceptual theory with design-led experimentation and user-based evaluation, the project seeks to translate existing knowledge about peripheral vision and attention into practical insights for lighting design. In doing so, the thesis aims to contribute to more inclusive, cognitively informed lighting strategies that go beyond visibility and task performance alone.

# Methodology

## Research Approach

This thesis adopts a mixed-methods, exploratory research approach, combining structured quantitative measures with qualitative observation and open-ended participant feedback to investigate how peripheral lighting conditions influence perceived distraction, visual comfort, and focus in low-light domestic environments. Mixed-methods approaches are particularly well suited to design-oriented and perceptual research, as they allow subjective experience, behavioural tendencies, and contextual interpretation to be examined in parallel (Creswell & Plano Clark, 2018). The study employs three primary methods: systematic behavioural observation, self-reported rating scales, and short semi-structured interviews. Together, these methods enable triangulation between observable behaviour and subjective experience, strengthening the interpretive validity of the findings.

Quantitative data were collected using Likert-type rating scales, a widely used method for assessing subjective perceptions such as comfort, distraction, and attentional stability in lighting research. These structured ratings allow for direct comparison between lighting scenarios and provide an overview of perceived differences across conditions. In addition, manual observation of gaze shifts away from the task area was used as a low-tech behavioural proxy for attentional reorientation. While this method does not provide the temporal precision of eye-tracking, observational approaches are commonly used in exploratory and ecologically grounded studies where the aim is to capture meaningful behavioural tendencies rather than fine-grained attentional metrics. Qualitative data were collected through brief open-ended interview questions following each lighting scenario. This method supports deeper insight into how participants interpreted and made sense of the lighting conditions, allowing perceptual nuances, emotional responses, and unanticipated effects to emerge. Short interviews are particularly valuable in design research, where experiential qualities may not be fully captured through predefined scales alone (Frayling, 1993; Zimmerman et al., 2007).

The research is design-driven and exploratory in nature. Rather than testing a narrowly defined hypothesis, the study investigates how variations in peripheral luminance, contrast, colour, and light placement are experienced during a centrally focused task. The comparison between participants with higher and lower self-reported distractibility is intended as an exploratory contrast rather than a statistical group comparison, and findings are interpreted as indicative tendencies within a small sample. By combining theory-informed lighting scenarios with user-based evaluation, the methodological approach bridges vision science, lighting design, and inclusive design principles.

## Experimental Setting

The experiment is conducted in a domestic environment resembling a study room. This setting was chosen to reflect everyday contexts in which users engage in visually focused activities under low-light conditions. Unlike standardized workspaces, domestic environments often involve heterogeneous lighting configurations, making them particularly relevant for investigating peripheral distraction and visual comfort.

Lighting conditions are systematically manipulated across a set of predefined scenarios. The primary variables include brightness distribution, contrast levels between central and peripheral areas, and the placement of light sources within the participant's peripheral visual field. Central task lighting is kept consistent across scenarios to ensure that observed differences in perception can be attributed primarily to changes in peripheral lighting.

Participants perform a visually focused task positioned within the central visual field. This task is held constant throughout the experiment to maintain comparable attentional demands across lighting conditions. While the experimental setup is low-tech, it allows for controlled manipulation of lighting variables and supports ecological validity by closely resembling real-world use situations.



# Design

## Design Rationale

The experimental design of this study is grounded in findings from vision science and lighting research that highlight the increasing role of peripheral vision and attentional mechanisms in low-light environments. As discussed earlier, reduced illumination levels lead to a shift from cone-dominated to rod-dominated vision, resulting in decreased visual acuity and colour sensitivity, while increasing sensitivity to contrast, motion, and luminance changes in the peripheral visual field. These perceptual changes have direct implications for how lighting is experienced beyond task-focused central vision. Despite this, conventional lighting design practice and standards primarily address central visual performance and horizontal illuminance at task level, offering limited guidance on how peripheral lighting conditions influence attention, comfort, and susceptibility to distraction. This gap suggests a need for experimental approaches that explore lighting not only as a tool for visibility, but as an environmental factor shaping perceptual and cognitive experience.

The experimental setup developed for this study therefore focuses on manipulating lighting conditions in the peripheral field of view while keeping the central visual task constant. By doing so, the study isolates the influence of peripheral brightness distribution, contrast, and light placement on subjective experiences of focus, comfort, and distraction. A domestic, low-light environment was deliberately chosen, as such settings are underrepresented in lighting research and are commonly characterised by mixed visual tasks, relaxed attention, and varied lighting conditions. Rather than aiming to optimize task performance metrics, the design prioritises experiential qualities that are difficult to capture through purely quantitative measures, such as perceived visual calmness, attentional stability, and environmental comfort. This aligns with a design-driven research approach, where experimental scenarios function as probes to explore how different lighting strategies are perceived and experienced by users. In addition, the experimental design reflects principles of inclusive design by acknowledging variability in attentional sensitivity among users. Instead of assuming a single “average” observer, the study explores how lighting configurations may support or hinder attention across a range of subjective experiences, without relying on clinical categorisation or diagnostic frameworks. This approach allows the findings to remain relevant to a broad user group while still addressing attentional diversity as a meaningful design consideration.

Overall, the design rationale of this experiment is to translate theoretical insights on peripheral vision and attention into a controlled yet realistic lighting scenario, enabling the investigation of how subtle changes in peripheral lighting conditions can influence user experience in low-light domestic environments.

## Pre-study

Prior to the development of the experimental lighting scenarios, a small exploratory pre-study was conducted to inform the design decisions of the main experiment. The purpose of this pre-study was not to generate statistically generalisable results, but to gain insight into how users subjectively describe distraction, comfort, and attentional challenges in low-light domestic environments. This approach is

consistent with design-driven research methods, where early qualitative input is used to guide the formulation of experimental conditions rather than to test hypotheses directly.

The pre-study consisted of a brief questionnaire. Questions focused on everyday experiences of low-light environments, including perceived sources of visual distraction, preferences regarding ambient versus task lighting, and situations in which maintaining focus felt particularly challenging. Participants were encouraged to describe their experiences in their own words, allowing recurring themes to emerge without imposing predefined categories. Analysis of the responses revealed several consistent tendencies. Participants frequently reported that bright or uneven light sources located outside the main task area were experienced as distracting, particularly in otherwise dim environments. Peripheral light sources such as accent lighting, reflections, or light spill from adjacent spaces were often described as drawing attention involuntarily, even when they were not consciously attended to. In contrast, lighting configurations with smoother luminance transitions and reduced contrast between the task area and surrounding space were generally associated with greater visual comfort and a calmer atmosphere.

These observations supported findings from the literature on peripheral vision and attentional capture, which indicate that luminance contrasts and salient peripheral stimuli can trigger involuntary shifts of attention. Importantly, the pre-study helped translate these abstract theoretical concepts into concrete design parameters that could be manipulated experimentally, such as brightness distribution, contrast levels, and the placement of peripheral light sources. The results of the pre-study directly informed the selection and development of the lighting scenarios used in the main experiment. Rather than serving as empirical evidence in themselves, the questionnaire responses functioned as a design input, helping to ensure that the experimental conditions reflected realistic and relevant lighting situations encountered in domestic low-light settings.

By grounding the experimental design in both existing literature and user-reported experiences, the pre-study strengthened the ecological relevance of the experiment while maintaining a clear distinction between exploratory input and systematic data collection. This approach allowed the subsequent experimental phase to focus on controlled comparisons between lighting scenarios, while remaining closely connected to real-world perceptual experiences.

## **Development of Lighting Scenarios**

The three lighting scenarios were developed to investigate how variations in peripheral illumination, contrast, and colour influence perceived distraction, visual comfort, and attentional stability during a centrally focused task. To support perceptual uniformity across the visual field, the correlated colour temperature of the central task light is allowed to vary slightly between scenarios where peripheral illumination is introduced. This adjustment aims to reduce chromatic and luminance contrast between central and peripheral zones, ensuring that differences in perceived distraction and comfort relate primarily to spatial lighting distribution rather than abrupt spectral contrasts.

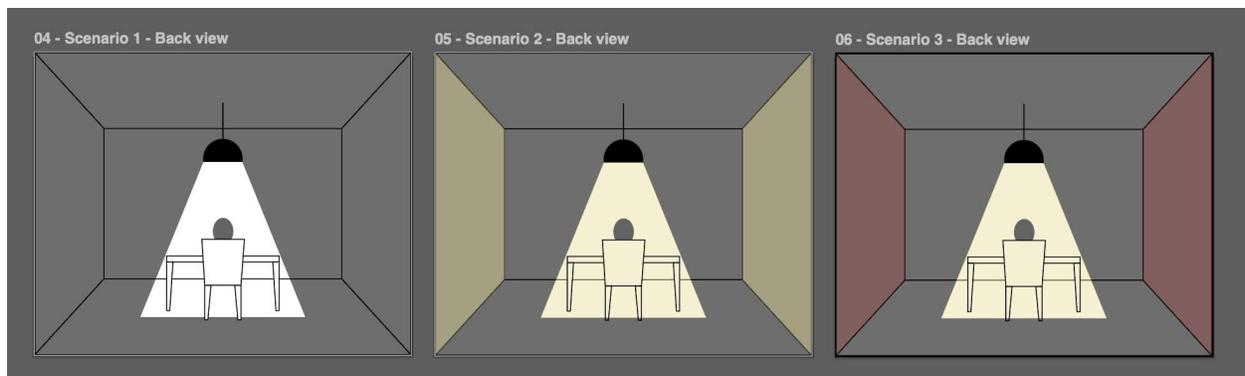
## Central Task Lighting

Across all scenarios, the task zone receives illumination from a suspended luminaire positioned directly above the work surface. The light source emits a neutral-to-cool white light, selected based on research indicating that higher correlated colour temperatures can support alertness, visual clarity, and sustained attention during cognitively demanding tasks (Boyce, 2014).

Taking into consideration studies addressing attentional performance and neurodivergent traits suggest that cooler or neutral white light may reduce subjective sleepiness and support task engagement for individuals with increased sensitivity to environmental stimuli. From a standards perspective, this choice aligns with recent revisions in lighting guidelines that increasingly acknowledge the non-visual effects of light, including alertness and circadian regulation.

The task lighting configuration therefore serves two purposes:

1. ensuring sufficient visibility and visual comfort for focused activity
2. providing a stable central reference condition against which peripheral lighting variations can be evaluated.



### Scenario 1: High Contrast with Peripheral Suppression

The first scenario illuminates only the task zone, while keeping surrounding walls and surfaces intentionally dark. This configuration creates a strong luminance contrast between central and peripheral areas, effectively suppressing peripheral visual information.

Such lighting strategies frequently appear in task-oriented environments where focus is prioritised through visual isolation. From a perceptual standpoint, this scenario tests whether minimising peripheral stimuli supports attentional stability, or whether the sharp luminance gradient increases visual strain or discomfort under low-light conditions due to adaptation demands.

This condition represents an extreme case of task-centric lighting, reflecting the emphasis on central vision found in many existing lighting standards and design practices.

## **Scenario 2: Reduced Contrast through Peripheral Wallwashing**

The second scenario introduces soft peripheral wallwashing to reduce luminance contrast between the task area and the surrounding space. In conjunction with this change, the central task light shifts slightly toward a warmer colour temperature compared to Scenario 1. This adjustment supports chromatic coherence between central and peripheral zones and reduces perceptual contrast across the visual field.

The combined use of peripheral wallwashing and a warmer task light creates a more uniform lighting environment while maintaining sufficient illuminance for task performance. This configuration reflects residential lighting strategies that prioritise visual comfort and spatial continuity over strict task isolation.

From a perceptual standpoint, the scenario investigates whether reduced luminance and chromatic contrast support sustained attention by lowering peripheral saliency and reducing adaptation demands in low-light conditions.

## **Scenario 3: Reduced Contrast with Coloured Peripheral Illumination**

The third scenario builds directly on the luminance and colour temperature configuration established in Scenario 2. The central task light maintains the same warmer colour temperature, ensuring consistency in task lighting and isolating colour as a variable in the peripheral field. Peripheral illumination introduces a red wallwashing component while maintaining comparable brightness levels to Scenario 2. This configuration allows examination of whether peripheral colour alone influences perceived distraction, visual comfort, or attentional stability, without introducing additional contrast through changes in illuminance or task-light spectrum.

By preserving chromatic consistency in the task zone, this scenario ensures that observed perceptual differences relate primarily to peripheral colour rather than changes in task visibility or central visual conditions.

The inclusion of a coloured peripheral lighting condition in this scenario is theoretically motivated by research on colour saliency, arousal, and attentional capture. Previous studies in colour psychology suggest that red light is associated with heightened arousal and increased perceptual saliency compared to more neutral spectral conditions (Elliot & Maier, 2014). When perceived in the peripheral visual field, highly saturated red stimuli may therefore function as salient cues that attract attention involuntarily, even when they are not directly relevant to the task at hand. At the same time, red and warm-coloured lighting is commonly used in domestic environments to evoke comfort, intimacy, and atmosphere. This creates a potential tension between affective comfort and attentional stability, particularly in low-light settings where peripheral sensitivity to luminance and colour contrasts is heightened. By introducing red wallwashing in the peripheral field while maintaining constant brightness and task-light conditions, Scenario 3 allows exploration of whether peripheral colour alone alters perceived distraction, focus, or visual comfort.

Rather than assuming coloured peripheral light to be inherently beneficial or disruptive, this scenario is designed to examine how spectral manipulation interacts with attentional processes under controlled low-light conditions. This approach supports a nuanced investigation of peripheral lighting strategies, acknowledging that design elements intended to enhance atmosphere may simultaneously introduce attentional saliency that affects task-focused activity.

## **Control of Environmental Variables**

All non-lighting variables remain constant across experimental conditions to limit confounding effects. The spatial layout, furniture placement, task materials, and participant position do not change between scenarios. In addition, a low-level ambient sound remains present throughout all conditions to reflect everyday domestic environments while ensuring consistency across participant experiences. Together, the three lighting scenarios form a structured progression from peripheral suppression to increased peripheral visual information. This progression supports comparative evaluation of how different peripheral lighting strategies influence attentional stability and visual comfort during focused activity. By grounding the experimental design in perceptual theory while maintaining ecological validity, the study bridges scientific research and lighting design practice in accordance with mixed-methods research principles.

## **Participants**

Eight participants took part in the experimental study. Participants were between 22 and 38 years old and represented a range of self-reported attentional experiences. Four participants reported ADHD-related attentional traits or increased susceptibility to distraction, while four participants reported no particular attentional difficulties.

All participants reported normal or corrected-to-normal vision and no known colour vision deficiencies. No participants reported neurological or visual conditions that could significantly affect visual perception beyond attentional variability. Participants were informed about the purpose and procedure of the study prior to participation and provided informed consent. Participation was voluntary, and all data were anonymised.

The grouping was not intended to support clinical comparison or diagnostic conclusions. Instead, it served as an exploratory way to examine functional differences in attentional sensitivity and subjective lighting experience. This approach aligns with the inclusive design perspective adopted in the thesis, which treats attentional diversity as a continuum rather than a categorical distinction.

## **Implementation**

### **Technical Setup**

The experimental lighting setup was designed to allow controlled manipulation of brightness, colour temperature, and spatial light distribution while remaining low-tech and representative of a domestic environment.

Three Philips smart light bulbs were used to regulate light intensity and hue across the different lighting scenarios. These light sources allowed precise adjustment of correlated colour temperature and dimming levels, supporting consistent reproduction of each experimental condition.

The central task lighting was provided by a single overhead luminaire equipped with extended side shielding to narrow the beam angle and limit light spill into the surrounding space. This ensured that illumination remained concentrated on the task surface while reducing unintended peripheral brightness.

Peripheral lighting was achieved using two luminaires with adjustable necks and extended side shielding. These fixtures were positioned behind the participant and directed toward the wall surfaces rather than into the room. This configuration allowed controlled wallwashing while minimising direct glare and preventing diffusion of light into the participant's central field of view. The placement also ensured that peripheral illumination remained perceptible without becoming a dominant visual stimulus.

All luminaires remained fixed in position throughout the experiment, with only intensity and colour parameters adjusted between scenarios. This ensured that differences in participant experience could be attributed to lighting characteristics rather than spatial reconfiguration.

### **Lighting Measurement and Parameter Definition**

Illuminance levels were measured using a calibrated handheld lux meter. Measurements were taken at the task surface and on representative peripheral wall surfaces at eye height. The same meter and measurement procedure were applied across all scenarios to ensure consistency.

The task surface was illuminated at approximately 250–280 lux in Scenario 1, and approximately 180–220 lux in Scenarios 2 and 3. These values were selected to remain below typical office lighting recommendations while ensuring sufficient visibility for a visually demanding task. The reduction in task illuminance in the latter scenarios was intended to limit overall luminance contrast between the task area and the surrounding visual field.

Peripheral illuminance levels were adjusted to create distinct contrast conditions. In the high-contrast scenario, peripheral wall illuminance was maintained at approximately 15–30 lux, resulting in a strong luminance gradient between the task area and its surroundings. In the reduced-contrast scenarios, peripheral wall illuminance was increased to approximately 80–110 lux, producing smoother luminance transitions and greater spatial coherence. Peripheral illuminance levels were kept comparable between Scenarios 2 and 3 to isolate spectral effects from changes in brightness.

Spectral characteristics were controlled using Philips Hue tunable LED luminaires. Exact spectral power distributions and correlated colour temperature values were not measured with a spectrometer and are therefore reported as nominal ranges based on manufacturer settings. Task lighting across all scenarios was maintained within a cool-to-intermediate white range (approximately 3500–4500 K), with minor adjustments introduced in Scenarios 2 and 3 to reduce chromatic contrast with the peripheral field.

Peripheral lighting in Scenario 2 employed warm white wallwashing (approximately 2700–3000 K). Scenario 3 introduced red-dominant peripheral wallwashing, while maintaining illuminance levels comparable to Scenario 2. This configuration allowed investigation of peripheral colour saliency without introducing additional luminance contrast.

The selected illuminance and spectral parameters were defined to create perceptually distinct, internally consistent, and ecologically plausible low-light conditions suitable for exploratory investigation of attentional experience, rather than to represent optimal or standardised lighting solutions.

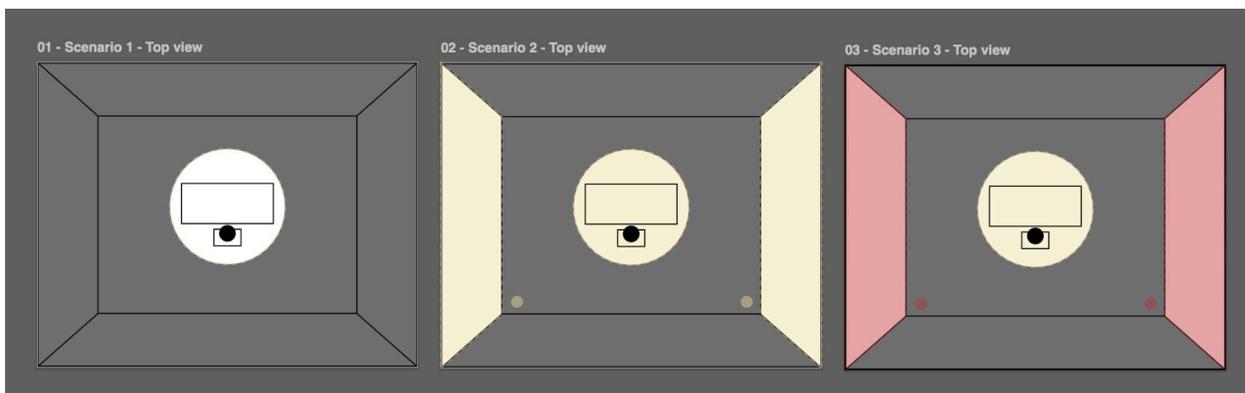
## Procedure

Each participant completed the experiment individually. Upon arrival, participants were introduced to the space and informed about the task they would perform. The specific focus on lighting and distraction was not disclosed in order to reduce expectation bias and avoid directing attention toward the lighting conditions explicitly.

Participants were seated at a table positioned at the centre of the room, maintaining a consistent viewing geometry across sessions. The experiment consisted of three lighting scenarios, each with a duration of approximately 15 minutes. Before the start of each scenario, lighting conditions were adjusted while the participant remained seated. A short adaptation period was provided before participants resumed the task.

The order of the lighting scenarios remained the same for all participants. This decision was made to maintain procedural consistency, while acknowledging the lack of counterbalancing as a methodological limitation.

During each scenario, participants worked continuously on the puzzle task at a self-selected pace. No time constraints were imposed. The researcher remained present in the space but positioned outside the participant's immediate field of view to minimise social or visual interference. Instances in which participants lifted their head and redirected their gaze away from the task area were recorded manually throughout each session.



## Data Collection and Analysis

Two forms of data were collected: observational data and self-reported data.

Observational data consisted of manually recorded instances of gaze shifts away from the task area during each lighting scenario. While this method does not provide the precision of eye-tracking technology, it offers a low-tech and ecologically valid indication of attentional shifts relevant to everyday domestic environments.

Self-reported data were collected immediately after each lighting scenario using a short questionnaire. Participants rated perceived visual comfort, level of focus, and degree of distraction using Likert-type scales. In addition, open-ended questions invited participants to describe what they noticed about the lighting and how it influenced their experience during the task.

Data analysis focused on identifying patterns and tendencies across lighting scenarios rather than establishing statistical significance. Given the exploratory nature of the study and the limited sample size, results are interpreted comparatively and qualitatively. Quantitative ratings are used to support observed trends, while qualitative responses provide contextual insight into how different lighting configurations were perceived and experienced.

## Results

### Data Analysis Approach

Data analysis followed an exploratory mixed-methods strategy consistent with the overall research design. Quantitative data (gaze shifts and Likert-type ratings) were analysed descriptively. For each participant and lighting scenario, the number of gaze shifts away from the task was counted, and mean values were calculated across participants. Likert ratings of comfort, focus, and distraction were summarised per scenario using means and visualised in bar charts to support comparison between conditions. Given the small sample size and the exploratory aim of the study, no inferential statistical tests were applied; patterns are interpreted as indicative tendencies rather than as generalisable effects.

Participants had been grouped a priori into two functional categories based on self-reported distractibility (higher vs. lower). For each group, scenario-wise averages were inspected to identify potential differences in how lighting conditions related to attentional stability and perceived comfort.

Qualitative data from open-ended questionnaire responses were analysed using a simple inductive content approach. Comments were read repeatedly and coded into recurrent themes such as *isolation/darkness*, *spatial coherence/calmness*, and *colour-related saliency*. These themes are used to contextualise the quantitative trends rather than to form a separate line of analysis.

## 5.2 Comparative Patterns Across Lighting Scenarios

Across participants, clear differences emerged between lighting scenarios in both behavioural and self-reported measures. The high-contrast scenario consistently resulted in the highest frequency of gaze shifts away from the task area. Participants in this condition redirected their gaze more often than in either of the reduced-contrast scenarios, indicating less stable task engagement. Qualitative comments support this pattern. Several participants described an increased awareness of the surrounding darkness and characterised the task area as “isolated” or “detached” from the rest of the room. These descriptions align with the notion that strong luminance contrast can heighten peripheral uncertainty, prompting more frequent monitoring of the environment.

In the reduced-contrast scenario with neutral wallwashing, participants generally exhibited fewer gaze shifts and reported higher levels of visual comfort and focus. The illuminated vertical surfaces appeared to reduce the perceptual dominance of the task light and create a more coherent spatial impression. Participants frequently described this condition as “balanced”, “calmer”, or “more natural”, indicating that smoother luminance transitions supported a more stable attentional state. The scenario with coloured peripheral lighting produced more mixed responses. Behaviourally, gaze shifts remained lower than in the high-contrast condition but slightly higher than in the neutral reduced-contrast scenario. While some participants described the warm red wallwashing as “cosy” or “supportive of focus”, others reported that the colour itself periodically drew attention. This suggests that spectral manipulation in the periphery can alter the qualitative experience of the space and may introduce new forms of visual saliency if not carefully calibrated.

Overall, the quantitative and qualitative data converge on a pattern in which reduced peripheral contrast and increased spatial coherence support more sustained task engagement and higher reported comfort, whereas strong central–peripheral contrast tends to increase attentional shifts and subjective distraction.

## 5.3 Attentional Diversity and User Experience

Differences between participants with higher and lower self-reported distractibility were most apparent in the high-contrast scenario. In this condition, the higher-distractibility group exhibited notably more gaze shifts than the lower-distractibility group and reported lower comfort and higher distraction on the rating scales. Several participants in this group described the environment as “restless”, “too sharp”, or “difficult to ignore”, suggesting that strong luminance contrast exacerbated their tendency to monitor the surroundings.

In the reduced-contrast scenario with neutral wallwashing, group differences decreased. Both groups reported higher comfort and focus and lower distraction, and gaze-shift frequency converged toward similar levels. Participants with higher distractibility occasionally noted that they felt “less need to check what is around” or that the room felt “more under control”, indicating that increased peripheral luminance reduced their perceived need for environmental scanning. Responses in the coloured peripheral scenario again showed greater variability. Some participants with higher distractibility experienced the coloured light as an additional attractor, while others reported no substantial difference relative to the neutral

reduced-contrast condition. This variability suggests that spectral changes in the periphery may interact with individual sensitivities in more complex ways than luminance contrast alone.

Taken together, the results indicate that lighting strategies which reduce strong central–peripheral contrast and support peripheral visibility may benefit a broader range of attentional profiles, particularly individuals who experience higher baseline distractibility. These findings remain exploratory but point toward the potential of peripheral lighting design as a tool for supporting attentional comfort in low-light domestic environments.

# Discussion

## Peripheral Lighting and Attentional Stability

The findings of this study suggest that peripheral lighting conditions play a meaningful role in shaping attentional experience during visually demanding tasks in low-light domestic environments. While all lighting scenarios ensured sufficient task visibility, differences in gaze behaviour and subjective reports indicate that attentional stability is influenced not only by central task illumination but by how light is distributed across the broader visual field.

In the high-contrast scenario, the strong luminance separation between the task area and the surrounding space appeared to increase attentional monitoring of the environment. Rather than supporting focus through visual isolation, this configuration may have heightened awareness of peripheral darkness, prompting participants to redirect their attention away from the task more frequently. This interpretation aligns with theories of peripheral vision, which emphasise heightened sensitivity to luminance contrasts and spatial uncertainty outside the central field of view.

Conversely, reduced-contrast peripheral lighting appeared to support more stable attentional engagement. By softening luminance transitions between central and peripheral zones, these lighting strategies likely reduced the perceptual saliency of the surrounding environment and lowered the need for continuous attentional scanning. This finding is consistent with attentional load theory, which suggests that environments with lower perceptual complexity and more predictable visual structure place fewer demands on attentional resources.

Importantly, these interpretations indicate that attentional comfort cannot be inferred solely from task visibility or illuminance levels. Even when central visual conditions were held constant, peripheral lighting influenced how participants experienced focus and distraction. This challenges task-centric assumptions in lighting design and underscores the importance of considering the full visual field when designing environments intended to support sustained attention under low illumination.

## Peripheral Colour, Saliency, and Attentional Trade-offs

The inclusion of a coloured peripheral lighting condition revealed a more complex relationship between atmosphere and attentional stability. While the red peripheral lighting scenario maintained reduced luminance contrast comparable to the neutral wallwashing condition, participants' responses were more varied, suggesting that colour introduced an additional perceptual dimension influencing attention.

From a perceptual standpoint, red light is commonly associated with heightened saliency and arousal, which may increase its capacity to attract attention when perceived in the peripheral visual field. For some participants, the red wallwashing was experienced as warm, calming, or supportive of focus, indicating that affective comfort can coexist with attentional engagement. For others, however, the colour itself appeared to function as a salient peripheral cue, periodically drawing attention away from the task. These mixed responses highlight an important design trade-off. While coloured peripheral lighting may enhance atmosphere and emotional comfort, it may also introduce new forms of visual saliency that interact with

attentional processes in unpredictable ways. This effect may be particularly pronounced in low-light environments, where peripheral sensitivity to contrast and colour differences is heightened due to increased reliance on rod-mediated vision.

Rather than framing coloured peripheral lighting as inherently beneficial or disruptive, the findings suggest that its impact depends on spectral intensity, spatial placement, and individual sensitivity. This reinforces the need for careful calibration of coloured lighting elements when designing environments that require sustained focus.

## **Attentional Diversity and Inclusive Lighting Design**

Differences in participants' self-reported attentional tendencies provided additional insight into how lighting conditions may be experienced unevenly across users. Participants who reported higher baseline distractibility tended to exhibit greater sensitivity to high-contrast peripheral conditions, showing increased gaze shifts and reporting lower comfort and focus. This suggests that strong central-peripheral contrast may amplify existing attentional challenges by increasing the perceptual demands of the environment.

In contrast, reduced-contrast lighting strategies appeared to support more consistent experiences across participants. In these conditions, differences between individuals with higher and lower self-reported distractibility became less pronounced, indicating that peripheral lighting coherence may help stabilise attention across a broader range of users. This levelling effect aligns with principles of inclusive design, which emphasise reducing unnecessary cognitive and perceptual demands rather than tailoring environments to specific user categories.

Importantly, these findings do not imply fixed differences in attentional ability or diagnostic distinctions. Instead, they highlight how environmental conditions can interact with everyday variations in attentional sensitivity. From a design perspective, this suggests that lighting strategies which moderate peripheral saliency may support attentional comfort not only for individuals who experience greater distractibility, but for all users.

## **Methodological Reflections and Limitations**

Several methodological limitations must be acknowledged when interpreting the findings. The small sample size and exploratory nature of the study limit the generalisability of the results. Observations of gaze behaviour were conducted manually, providing only a coarse proxy for attentional shifts compared to eye-tracking technologies. In addition, the fixed order of lighting scenarios introduces the possibility of adaptation or learning effects. The experimental design also involved bundled variables in some scenarios, particularly where peripheral luminance and colour temperature adjustments were made concurrently. While these choices were theoretically motivated and design-relevant, they limit the ability to attribute effects to single variables with precision. At the same time, these limitations reflect deliberate methodological trade-offs. The low-tech, domestic setup prioritised ecological validity and accessibility, aligning with a research-through-design approach. Rather than aiming for statistical precision, the study sought to generate perceptually grounded insights that are transferable to real-world lighting design practice.

## Directions for Future Research

While this study provides exploratory insights into how peripheral lighting conditions influence attentional experience in low-light domestic environments, several avenues for future research emerge from its findings and methodological scope.

One important direction concerns the inclusion of self-luminous screens. In contemporary domestic and work-related contexts, it is increasingly rare for visually demanding activities to be performed without screens, such as laptops, tablets, or televisions. These displays introduce an additional layer of luminance contrast and dynamic visual content that interacts with ambient and peripheral lighting conditions. Future studies could investigate how screen-based light sources alter peripheral saliency, attentional stability, and perceived distraction, particularly when combined with different peripheral lighting strategies. Examining the interaction between ambient lighting and screen brightness, colour temperature, and content dynamics would significantly enhance the relevance of this research to everyday environments.

A second promising direction involves extending the investigation to group-based, shared-attention activities. Tasks such as board games, collaborative work, or social gatherings require individuals to divide attention between a central activity and the actions of others in the surrounding space. In such contexts, peripheral vision plays a crucial role in monitoring movement, social cues, and turn-taking behaviour. Future research could explore how peripheral lighting conditions influence attentional balance, comfort, and engagement in group settings, where visual focus is distributed rather than fixed.

Related to this, future studies could explicitly introduce movement within the peripheral visual field as an experimental variable. Human movement is a highly salient peripheral stimulus and may interact strongly with lighting conditions, particularly in low-light environments. By incorporating controlled peripheral motion - such as other participants moving, gesturing, or changing position - researchers could examine how lighting strategies modulate attentional capture in dynamic, socially active environments.

Methodologically, future research could benefit from combining the low-tech, ecologically grounded approach used in this study with more precise measurement tools, such as eye-tracking or physiological indicators of arousal. Such hybrid approaches could provide deeper insight into the mechanisms underlying attentional shifts while preserving design relevance and real-world applicability.

Finally, longitudinal studies examining prolonged exposure to different peripheral lighting conditions could offer valuable insight into adaptation effects and long-term attentional comfort. Understanding how users acclimate to lighting environments over time would support the development of lighting strategies that remain supportive beyond short-term tasks or experimental sessions.

Together, these directions highlight the potential for further research to expand the understanding of peripheral lighting as a key factor in attentional experience, particularly in complex, screen-mediated, and socially interactive environments.

# Conclusion

This thesis investigated how peripheral lighting conditions influence perceived distraction and focus during a visually demanding task in a low-light domestic environment, with particular attention to variability in users' self-reported attentional tendencies. Motivated by gaps in existing lighting standards and research, the study moved beyond task-centric notions of visibility to explore how the broader visual field contributes to attentional comfort and user experience.

The findings demonstrate that peripheral lighting plays a meaningful role in shaping attentional stability, even when central task visibility is maintained. Lighting configurations characterised by strong luminance contrast between the task area and the surrounding environment increased attentional monitoring and perceived distraction. In contrast, reduced-contrast peripheral lighting strategies that supported greater spatial coherence resulted in fewer attentional shifts and higher reported comfort and focus. Attentional experience is therefore influenced not only by what users look at directly, but by how the surrounding visual field is illuminated. The investigation of peripheral colour revealed that lighting designed to enhance atmosphere can introduce complex attentional effects. Coloured peripheral illumination, while experienced as comfortable or supportive by some participants, was perceived as salient or distracting by others. This highlights a critical design trade-off between affective qualities and attentional stability, particularly in low-light environments where peripheral sensitivity is heightened. The findings indicate that the impact of coloured peripheral lighting depends on careful calibration of spectral intensity, spatial placement, and consideration of individual sensitivity rather than being inherently beneficial or disruptive.

Differences related to self-reported attentional tendencies revealed how lighting conditions are experienced unevenly across users. Participants who described themselves as more easily distracted showed greater sensitivity to high-contrast peripheral conditions, while reduced-contrast lighting strategies supported more consistent experiences across participants. These patterns reinforce the relevance of inclusive lighting design approaches that reduce unnecessary perceptual and cognitive demands, benefiting a broader range of users without relying on clinical categorisation.

From a design and standards perspective, the thesis demonstrates that compliance with established lighting guidelines does not guarantee attentional comfort, particularly in informal or domestic settings. While standards such as EN 12464-1 effectively address visibility and baseline visual comfort, they offer limited guidance on peripheral luminance distribution, contrast, and colour as factors shaping attentional experience. The findings point toward the necessity of complementary design considerations that account for the full visual field and its role in attentional regulation, particularly in environments where sustained focus is required under low illumination.

Methodologically, the study demonstrates that low-tech, design-driven experimental approaches can generate meaningful insights into perceptual and attentional aspects of lighting. Although the exploratory nature of the research and the limited sample size restrict generalisability, the emphasis on ecological validity and experiential evaluation aligns with the practice-oriented goals of lighting design research. In conclusion, this thesis contributes to an expanded understanding of lighting as more than a tool for visibility. By demonstrating the role of peripheral lighting conditions in shaping attention, comfort, and distraction, it establishes the importance of perceptually and cognitively informed design strategies. In low-light domestic environments, where traditional standards offer limited guidance, designing for peripheral coherence and attentional comfort supports more inclusive, supportive, and user-centred

lighting practice. Future lighting design should therefore integrate peripheral visual field considerations alongside task-oriented metrics to create environments that accommodate diverse attentional needs and support sustained cognitive comfort.

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