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Reflective Facades' Impacts on Visual Perception and Psychological Responses

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Abstract

While increasingly popular for their aesthetic appeal and energy efficiency, reflective materials may also create harsh glare, disorientation, and psychological strain. Despite their prevalence in modern architectural design, the impact of these facades on mental well-being remains underexplored. Drawing from environmental psychology and perceptual science, this study assesses how different reflective materials influence both visual perception and psychological response, particularly among residents and students in Leicester. Two contrasting case studies, the reflective metal Highcross centre facade and the reflective glass Mattioli Woods PLC facade, served as focal points. Using a structured online questionnaire incorporating visual stimuli and Likert-scale questions, responses from 30 participants were analysed using descriptive and statistical analysis (i.e., one-way ANOVA) to determine differences in visual discomfort (due to brightness, glare, or shine), visual attractiveness, visual disorientation, and perception of the surroundings, as well as the associated physiological responses such as stress, tension, and mood. Results show that the Highcross Centre facade was consistently perceived as more visually discomforting and disorienting than the Mattioli Woods facade, with statistically significant differences. However, both facades were rated similarly high for visual interest, suggesting that aesthetic value can coexist with discomfort. Finally, the analysis shows that buildings' reflective facades evoke only low levels of perceived stress, tension, or unease, with median scores remaining low overall. These findings highlight the importance of human-centred facade design, suggesting that, as cities adapt to climate change, architects and urban planners consider not only environmental performance but also perceptual and psychological effects.

Keywords: facade design; facade material; sustainable urban environments; user perception; visual comfort

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1. Introduction

Reflective facades are architectural exterior elements designed to mirror their surroundings, utilising materials such as mirrored glass, polished metal panels, or reflective ceramics to achieve this effect [1]. Unlike transparent facades that allow visibility into a building's interior, reflective facades obscure internal views, instead projecting images of the external environment to the outside viewers. This design approach not only enhances the aesthetic appeal of a structure but also fosters a dynamic interaction between the building and its context, as the reflections change with varying sky conditions, light dynamics, and view perspectives. According to [2], reflective facades have gained prominence in

contemporary architecture for their ability to blend structures seamlessly into their environments, create visual illusions, and evoke curiosity among observers. These facades act as a medium of communication between the built environment and the public, offering a unique visual experience that evolves throughout the day.

In the context of the external urban environment, visual comfort refers to the ability of urban spaces to provide pleasant and manageable visual experiences in outdoor settings. Besides the aesthetic experience that exterior buildings create, visual comfort should be considered to minimise negative visual stimuli such as excessive brightness, harsh glare from reflective materials [3], and high contrast between shaded and sunlit areas, all of which can disrupt visual perception and contribute to discomfort. Research shows that unmanaged daylight exposure and reflections from building facades can negatively affect the quality of the visual environment [4]. This essentially means that highly reflected facades not only affect visual comfort but also the psychological well-being. Prolonged exposure to such visually stressful environments has been associated with increased cognitive strain and elevated stress levels [5,6], particularly in urban areas where reflective glass facades and polished surfaces are prevalent. Addressing visual comfort in outdoor architectural design is therefore critical for enhancing the overall quality of urban spaces and promoting public mental health.

Recently, the increasing use of highly reflective materials such as glass and metal cladding in modern facades has introduced considerable challenges related to glare in urban spaces. Reflective facades were found to contribute to elevated levels of outdoor glare, particularly in dense urban environments, leading to discomfort and reduced visual quality for street pedestrians [7]. This reflected glare not only causes temporary visual discomfort but also increases cognitive load as individuals attempt to navigate visually challenging environments. The extent of glare discomfort is further influenced by facade design choices, with larger reflective surfaces and concave geometries intensifying the negative impact on pedestrians and urban assets [7]. As a result, careful consideration of facade materials and geometries is essential to mitigate glare-related discomfort and enhance the visual quality of urban public spaces. Visual comfort also plays a critical role in shaping individuals' psychological responses to the built environment. When visual environments fail to provide adequate comfort due to factors such as glare, excessive brightness, and poor luminance balance, they can lead to visual fatigue and heightened psychological stress. The authors of [8] highlight that discomfort glare, especially from daylight and reflective surfaces, acts as a significant environmental stressor by disrupting visual perception and increasing cognitive load. The constant effort required to adapt to high-contrast lighting conditions triggers both physiological and psychological strain. Over time, visual discomfort has been shown to reduce emotional well-being and contribute to feelings of irritation, anxiety, and dissatisfaction with the environment.

As urban environments increasingly incorporate reflective materials to achieve an aesthetic, polished, and contemporary or eye-catching appearance, understanding the connection between facade design and pedestrians' visual perception becomes essential for creating healthier and more supportive public spaces. In fact, there are growing concerns about how architectural design influences users' comfort and well-being. This research thereby explores how prolonged exposure to intense reflections, glare, and visually uniform facades may contribute to discomfort and increased psychological stress. To address the wider implications of building facade design and street pedestrians' comfort, a literature review is presented in Section 2 to highlight some of the key aspects.

2. Literature Review

While reflective facades are visually striking, offering a sleek aesthetic, lightness, and energy performance, they often lead to excessive daylight reflection and urban glare. Ishak et al. [7] investigated glare in tropical urban environments and found a strong relationship between prolonged exposure to reflective glare and increased visual discomfort, particularly among older populations. Their survey of 500 individuals across four Malaysian cities showed that the age and duration of exposure significantly affected perception, with older individuals being more sensitive to discomfort. These findings align with neuroscientific evidence showing that urban environments rich in visual stimuli, especially with disorienting or complex patterns, activate stress-related areas of the brain. Winz et al. [9] demonstrated that urban experince may exhibit increased physiological responses of arousal and expressed feelings of discomfort. suggesting that overstimulating visual environments, like those created by glare from reflective facades, may increase vulnerability to stress-related mental health issues. Other researchers [10] also looked at how building facades impact people's emotional well-being. While their study was not specifically about reflective facades, it showed that poorly designed facades made people feel less safe and more uncomfortable. This further supports the idea that how buildings look and interact with their surroundings can have real psychological effects.

2.1. Measurement and Analysis of Glare

Since reflective facades are known to produce high levels of glare, being able to quantify this effect helps us better evaluate how such architectural features influence everyday experiences in urban environments. The author of [11] proposed dual methods combining subjective ratings with objective metrics such as luminance ratios. His research emphasised that discomfort glare does not necessarily impair visual function but rather induces physical reactions like squinting and fatigue. Further studies have refined glare measurement tools. Kent et al. [12,13] and Fotios & Kent [14] discovered that individuals working in brighter environments exhibit increased glare tolerance, especially later in the day, due to light adaptation. Quantitative metrics such as Daylight Glare Probability (DGP) and Daylight Glare Index (DGI) have been introduced. As demonstrated by Xue et al. [15], DGP can objectively evaluate the visual impact of reflective surfaces through simulated lighting conditions. Nevertheless, it is argued that glare indices are not an ideal determinant of discomfort under direct light or when specular reflections are present in a field of view or in the presence of large sources of luminance [16]. In addition, glare sensation involves much more than measurements [17]. Discomfort is often accompanied by physical responses like squinting and eye fatigue, which, over time, contribute to elevated stress levels. Quek et al. [18] found that, when comparing different subjective assessment methods of glare, people's responses were consistent, no matter how the questions were worded. This means that even when subjective studies use slightly different survey methods, they are still getting reliable information about how uncomfortable glare makes people feel.

2.2. Influence of Material and Geometry

Reflectivity levels are not just dependent on surface type but also on material finish and geometry. Speroni et al. [19] demonstrated that concave and mirrored surfaces can intensify ground-level reflected sunlight by over 300%, making public spaces significantly less comfortable. Suk et al. [20] added empirical weight by analysing London's Walkie Talkie building, where the concave glass design produced heat spots intense enough to melt car parts. Their high dynamic range imaging revealed that 13% of participants experienced disturbing glare from such surfaces. Xue et al. [15] emphasised that even

flat transparent facades with high transmissivity could cause discomfort without shading devices, especially in areas like libraries or offices. These issues are further compounded when buildings are clustered close together, allowing sunlight to bounce across surfaces and elevate glare intensity at the street. The study also pointed out that people might tolerate outdoor glare more than indoor glare. The effect of glare caused by the reflective material of the external facades can extend to occupants in adjacent indoor buildings, as in the case of the Nasher Museum in Texas, where discomfort glare was received by the visitors due to the reflected light on a surrounding tower [3].

2.3. Visual Discomfort and Psychological and Physiological Responses

Though many architectural studies concern visual discomfort, neuroscience research delves into deeper physiological effects. As such, refs. [6,9] explored how sudden exposure to intense glare triggers the brain's fight-or-flight response, elevating cortisol levels and contributing to long-term health risks if exposure is prolonged. This is the body's way of reacting to a perceived threat; even though glare is not dangerous, the brain still responds as if it is. Dai et al. [21] found that students exposed to reflective facades during the COVID-19 lockdown reported increased anxiety and lower academic performance. Even though this study focused on people indoors, it clearly shows how the visual characteristics of facades can influence stress and well-being. Where people are constantly exposed to building exteriors, this could have important implications for facade design and materials [22]. St-Jean et al. [5] also emphasised that shifting or unstable reflections that are common on glass curtain walls do require constant visual adjustment, leading to eye fatigue and mental exhaustion. This is consistent with the findings of [23], who argued that complex, incoherent environments lead to attentional fatigue and psychological strain. Coburn et al. [24] provided further psychological grounding by introducing three core cognitive–emotional responses to architectural environments: coherence, fascination, and hominess. When a facade design lacks coherence, such as due to harsh reflections or angular, repetitive forms, it could contribute to disorientation and discomfort. Their fMRI findings showed that spatial environments rated as more coherent and homely elicited more favourable neural responses, including lower activation in the stress-associated brain.

In terms of physiological and cognitive effects, reflected light acts as a secondary visual stimulus, which the perceptual system must process alongside direct illumination. Unlike direct light sources, reflections can be misleading and disorienting, triggering additional cognitive load. The visual cortex must work harder to decode ambiguous or unstable reflected images, especially when combined with changing sunlight throughout the day. This introduces a higher cognitive load, especially when light reflections are bright, ambiguous, or mobile (e.g., from passing clouds or pedestrians).

According to [24], such visual complexity engages the brain's sensorimotor and valuation networks, requiring additional attentional time. This overstimulation can lead to stress-related symptoms like headaches, irritability, and fatigue [2]. Furthermore, glare does not affect all demographics equally. Studies have shown that children, older adults, and individuals with sensory sensitivity are more prone to discomfort from intense reflections [25].

Together, these studies show a clear progression from short-term discomfort to serious long-term health impacts if glare is not properly managed. Furthermore, although prior studies have examined glare and visual discomfort, few have explored how urban-scale reflective facades impact both visual comfort and perceived stress, representing both conceptual and contextual gaps. This raises equity concerns in urban design, where certain populations may disproportionately suffer the consequences of aesthetic-driven architecture. In response, this study aims to investigate the relationship between reflective

facades and the visual perception and psychological responses of street pedestrians in urban environments. Derived from the literature review, the study concerns aspects of visual perception: visual discomfort (due to brightness, glare, or shine), visual attractiveness, visual disorientation or confusion, and perception of the surroundings, as well as the associated physiological responses such as stress, tension, and mood.

3. Research Method

This study adopted a quantitative, cross-sectional research design to evaluate how reflective building facades influence visual perception and psychological responses within an urban environment. This design was chosen because it enables the collection of measurable data from a broad sample at a single point, making it ideal for identifying patterns in perception and experience without requiring long-term observation.

3.1. Case Studies

Research methodology was designed to examine the subjective responses to reflective facades. Two key architectural case studies were selected: The Highcross shopping centre building and the Mattioli Woods PLC building, both located in Leicester, UK. The Highcross shopping centre building encompasses four-level commercial and leisure buildings, with the cinema complex comprising approximately 80,000 sq ft of space. Figure 1—top shows the reflective metal cladding south facade of the building. The stainless-steel cladding features buckled Grade 316L panels with a satin finish. The Mattioli Woods PLC building is a six-story office block, part of a modern development, with approximately 60,000 sq ft occupied by Mattioli Woods on multiple floors. Figure 1—bottom shows the west-oriented facade of the building featuring a fully glazed curtain wall. The glass curtain wall is based on Senior's thermally broken SF52 aluminium system, executed in a faceted stick-built format. Customised mullions were fabricated to match the facade's organic geometry. The two buildings were selected due to their highly reflective facade materials, fully metal and fully reflective glass facades, respectively, in order to provide contrasting material choices to explore the relationship between facade materiality, human perception, and psychological well-being.



Figure 1. The south facade of the Highcross shopping centre building (**top**); the west facade of the Mattioli Woods PLC building (**bottom**).

The public responses to these two facades were collected to understand how the reflective facades affect levels of glare, brightness perception, and associated emotional

responses such as discomfort, stress, or visual strain. This design supported the study's aim to uncover the impact of reflective facades on the visual perception of pedestrians and how it affects their psychological responses in urban settings.

3.2. Data Collection and Sampling Methods

Primary data were gathered using a self-administered online questionnaire, distributed via Microsoft Forms. This survey method was chosen for its practicality, allowing efficient data collection from a wide audience while ensuring ease of access and completion. This method is also derived from past studies concerning users' visual perception in architectural contexts [26,27]. Additionally, the online format supported full participant anonymity, which helped encourage honest and unbiased responses. A convenience sampling strategy was used, targeting Leicester residents and students familiar with the selected case study buildings. Overall, 30 participants were recruited. Data collection took place in May 2025. While this limited the statistical power of the study, the data collected still offered valuable insights into the subjective experiences of those who frequently interact with reflective facades in an urban environment.

The questionnaire was carefully structured to collect data across several key sets of questions. The first one concerned the demographic information (e.g., gender, residency) and whether the participants were Leicester residents as a key selection criterion. This is to establish familiarity with the buildings that influence perceptions.

Questions in set two were designed to help participants visualise the specific facades being assessed using images of the Highcross shopping centre and Mattioli Woods PLC buildings. Using images allowed participants to form more accurate judgments based on their personal experiences and immediate visual impressions, simulating real-world exposure as closely as possible within the constraints of an online survey. In the third set of questions, the participants were asked to rate their agreement with statements, using a Likert scale of 1 to 5 (with 1 being strongly disagree, 3 being neutral, and 5 being strongly agree). These statements ranged from visual discomfort, visual attractiveness, disorientation, and perceived changes to their environment. These questions were specifically designed to explore how brightness, glare, and reflections contribute to discomfort or enhance visual interest.

For the fourth set of questions, psychological and emotional impacts were investigated. Respondents were asked to assess whether the reflective facades made them feel stressed, tense, or affected their mood and focus. These questions connected architectural design to emotional well-being, supporting the study's broader aim of exploring the psychological impacts of reflective environments.

Following these sets of questions, the participants were asked to directly compare the Highcross shopping centre and Mattioli Woods PLC buildings. This is to compare the responses to both buildings and understand which facade material was perceived as more visually comfortable and which induced greater discomfort or eye strain. Lastly, an open-ended question (optional) was included to allow the participants to share any additional comments. This qualitative input provided further context to the numerical data and highlighted subjective experiences that might not have been captured by the structured questions.

Ethical approval was obtained from De Montfort University's Research Ethics Committee before the research commenced. Participants were presented with a detailed Participant Information Sheet outlining the study's objectives, the voluntary nature of participation, and the measures taken to ensure data confidentiality and anonymity. Informed consent was obtained digitally before participants could proceed with the questionnaire. All activities were conducted by the university's Research Ethics Code of Practice.

3.3. Data Analysis

Data collected through the questionnaire were analysed using descriptive statistics, including the calculation of means and medians presented through boxplot charts to summarise the distribution of participant responses. The one-way independent ANOVA test was used to examine the statistical difference in the subjective responses to the different conditions [28], i.e., facade types. The traditional alpha thresholds were used to determine whether differences are statistically significant, specifically the cases in which the *p-value* was lower than 0.05. This analysis was critical for understanding whether there was a measurable link between architectural design and psychological outcomes.

4. Results and Findings

This study explored how reflective facades influence visual comfort and psychological well-being, focusing on two Leicester buildings: the Highcross shopping centre (metallic) and the Mattioli Woods PLC building (glazed facade). In total, 30 subjects evaluated their visual experiences with the two buildings (24 male, 4 female, and 1 unidentified). Results are presented thematically and aligned with the research objectives.

4.1. Visual Perception of Reflective Facades

Participants were asked questions to determine how the reflective facades of both buildings influenced their visual experience in terms of visual discomfort (due to brightness, glare, or shine), visual attractiveness, visual disorientation or confusion, and perception of the surroundings.

Figure 2 illustrates the boxplots of key visual responses to both buildings. The Highcross shopping centre received a median score of M = 2 for causing visual discomfort, indicating a slightly higher level of discomfort compared to the Mattioli Woods PLC building, for which M = 1. This implies that the reflective metal facade may be more prone to causing visual discomfort or uncomfortable reflections compared to the reflective glazing.

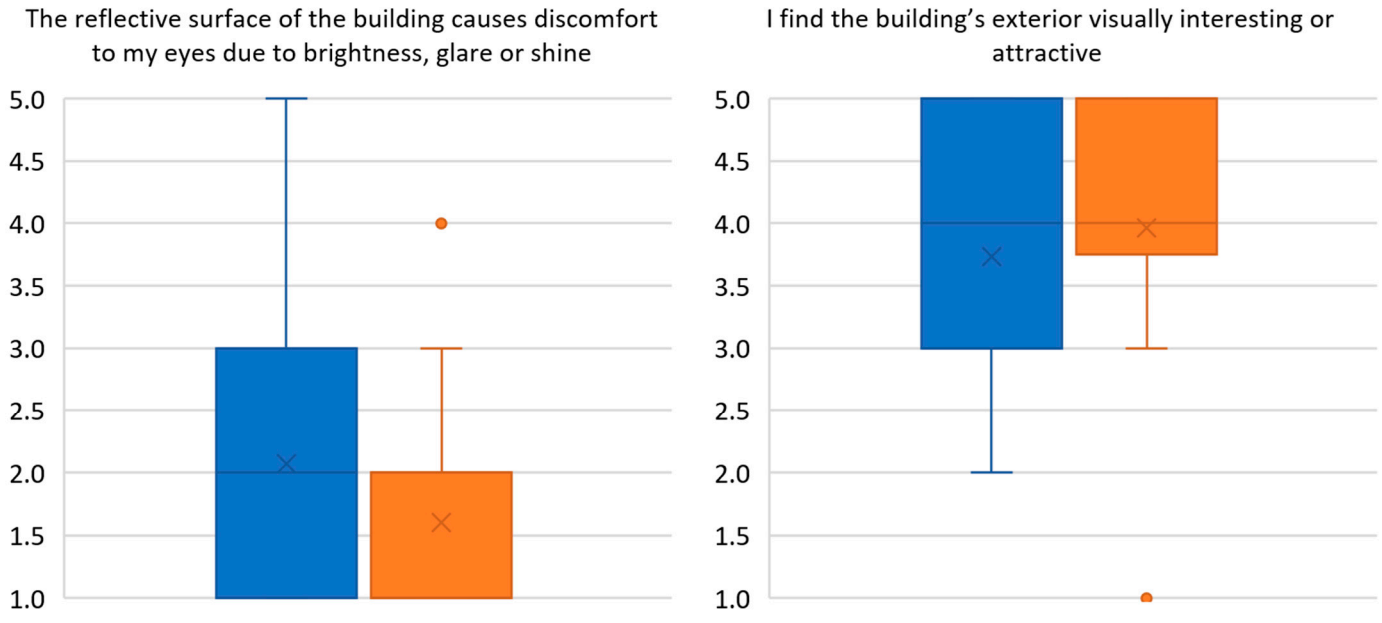


Figure 2. *Cont.*

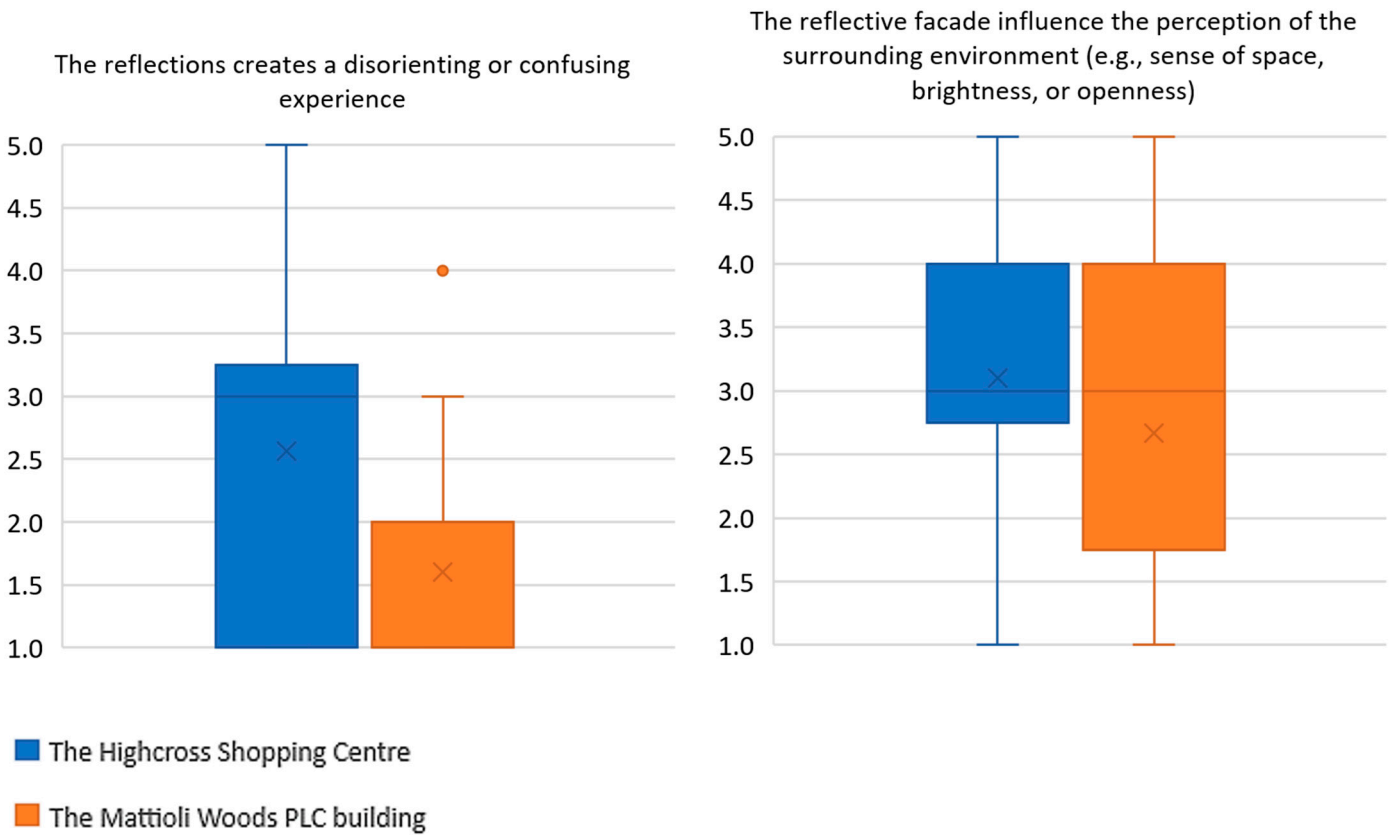


Figure 2. Boxplots of subjects' visual perception of the reflective facades of the Highcross shopping centre and the Mattioli Woods PLC building.

In terms of visual interest, both the Highcross shopping centre and the Mattioli Woods PLC building were generally perceived as visually attractive (M = 4). On the other hand, a notable divergence occurred concerning disorientation and confusion from facade reflections, as the Highcross shopping centre building scored 3, whereas Mattioli Woods scored 1, suggesting significantly lower confusion linked to the reflective glazing facade. Both buildings had equal median scores (M = 3) for influencing spatial perception.

4.2. Psychological Responses to Reflective Facades

The survey captured participants' emotional and psychological responses to the reflective facades, specifically in terms of stress, tension, and distraction. See Figure 3. The descriptive analysis shows that both buildings' facades slightly evoke stress with low average scores (~2 out of 5). Nevertheless, some outliers exist (ratings up to 4 or 5), representing a few respondents, but overall, respondents did not strongly agree that the facade evokes stress.

The median score for stress related to the Highcross shopping centre's facade was low (M = 1.5), slightly higher than Mattioli Woods (M = 1). This indicates a minimal impact of both facades on tension or unease (M = 1). In terms of mood or focus, the Highcross shopping centre's metal facade had a slightly higher impact (M = 2) compared to Mattioli Woods (1.5), as revealed by the respondents.

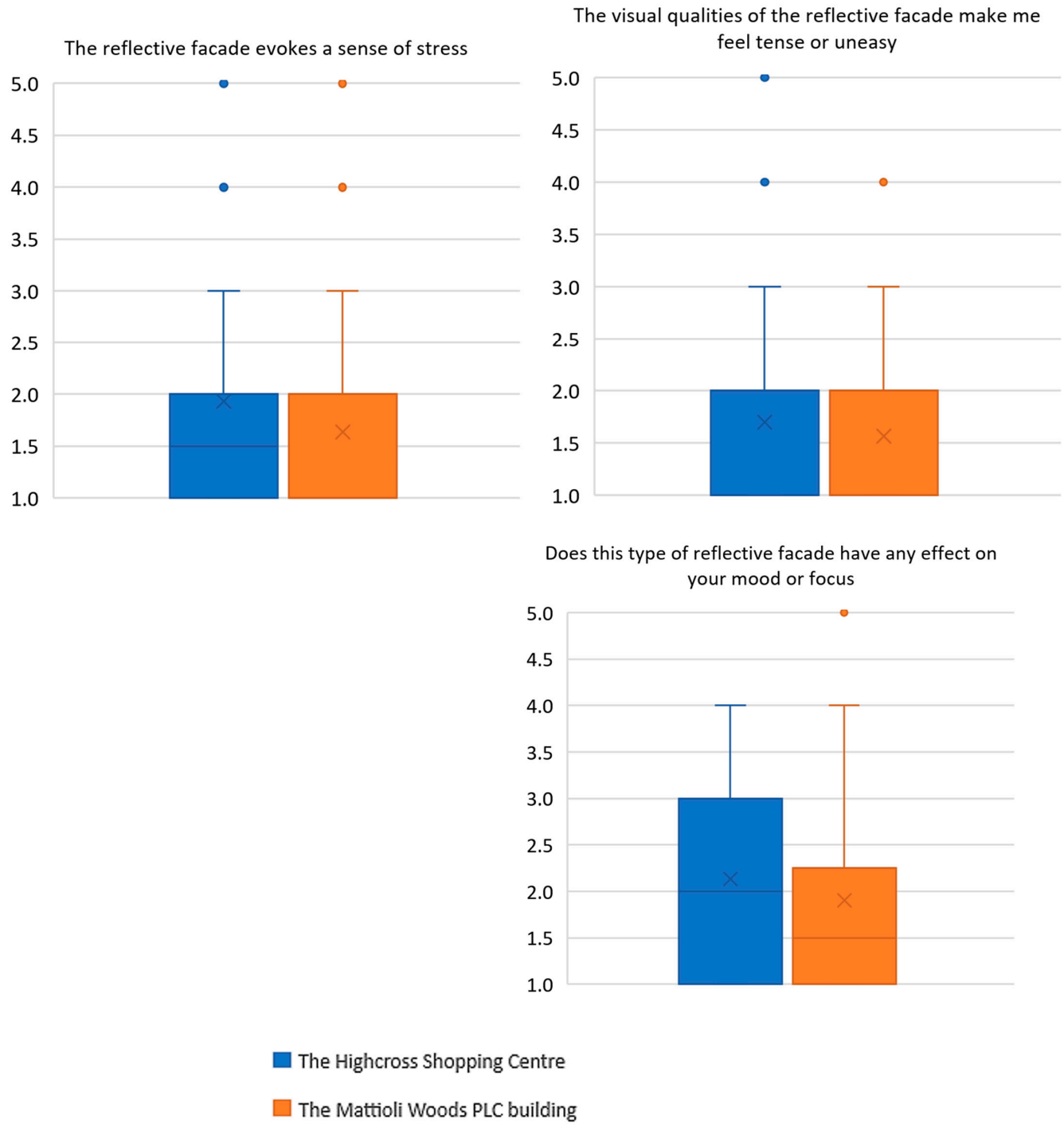


Figure 3. Boxplots of subjects' psychological responses to the reflective facades of the Highcross shopping centre and the Mattioli Woods PLC building.

4.3. Comparative Analysis

To compare visual perception between the two facades, a one-way ANOVA was conducted to compare the effect of the reflective facade on perceived discomfort between the metal reflective facade of the Highcross building and the reflective glazing facade of the Mattioli Woods building (see Table 1). The results showed that the mean rating for the Highcross centre's facade was slightly higher than for the Mattioli Woods PLC facade (F-statistic = 3.32, *p-value* = 0.074). Although this difference did not reach statistical significance (*p-value* > 0.05), it suggests a potential trend indicating that the Highcross shopping centre's reflective metal facade may be associated with slightly higher levels

of perceived discomfort. In terms of facade attractiveness, the ANOVA test showed that the difference in respondents' ratings between the Highcross shopping centre and the Mattioli Woods PLC facades was not statistically significant (*p-value* ~0.35). Nevertheless, the analysis revealed a statistically significant difference, F(1, 58) = 11.86, *p-value* = 0.001, between subjects' feedback on both facades, causing disorientation and confusion. This result suggests that metal reflective surface treatments may lead to greater visual confusion compared to reflective glazing, which could have implications for pedestrian comfort and wayfinding in urban environments. On the other hand, the analysis returned marginal differences in the perception of the surrounding environment between the two facades, F(1, 58) = 1.79, *p-value* = 0.186. While differing in their impact on disorientation, it seems that the difference in facade material did not significantly influence participants' overall perception of the surrounding context.

Table 1. Summary of the one-way ANOVA test used to compare the visual perception of the two facades.

Tested Variable	F-Statistic	*p-Value*	Eta Squared (Effect Size)
Visual Discomfort	3.32	0.074	0.054
Visual Attractiveness	0.9	0.348	0.015
Disorientation/Confusion	11.86	0.001	0.170
Perception of Surroundings	1.79	0.186	0.030
Sense of Stress	1.08	0.304	0.018
Tense or Uneasy	0.3	0.586	0.005
Mood or Focus	0.62	0.434	0.011

To compare the perceived sense of stress evoked by the reflective facades, ANOVA was performed. The ANOVA results showed no significant difference between the Highcross shopping centre and the Mattioli Woods PLC facades, F(1, 58) = 1.08, *p-value* = 0.304. Similarly, no statistically significant difference was observed in how tense or uneasy respondents felt near the Highcross shopping centre facade versus the Mattioli Woods PLC facade (*p-value* > 0.05). Also, no statistically significant difference was found in how the reflective facades affected people's mood or focus (*p-value* > 0.05).

5. Discussion

Drawing on the responses from 30 participants who assessed the Highcross shopping centre and Mattioli Woods PLC buildings in Leicester, the discussion critically compares the findings with the existing literature and theoretical frameworks. The implications of material choice, facade design, and user experience are considered, alongside the limitations of the research and its potential value for architectural practice and urban policy.

The data analysis shows that the Highcross shopping centre, with its reflective metal facade, was consistently rated as more visually discomforting and disorienting than the Mattioli Woods PLC building, which has a reflective glass facade. These results support earlier studies. For instance, Ishak et al. [7] emphasised that highly reflective facades increase discomfort due to glare, particularly in urban contexts. Although their work was conducted in the high-sunlight environment of Kuala Lumpur, this study affirms that even in the UK's less intense lighting conditions, glare remains a meaningful stressor. The finding that the Highcross shopping centre's facade caused greater discomfort than that of Mattioli Woods adds nuance to this by suggesting that materiality (metal vs. glass) significantly moderates the visual impact of reflectivity. Likewise, Pierson et al. and Vos [8,11] described

discomfort glare as a source of cognitive strain, even if visual acuity is not directly impaired. The eye's constant adaptation to bright reflections leads to stress and fatigue, which aligns with participant responses, especially the higher scores of disorientation and distraction linked to the Highcross shopping centre's facade.

Median scores revealed that the reflections from the Highcross shopping centre were perceived as more visually confusing and emotionally taxing, with large differences compared to the Mattioli Woods facade. A notable physical characteristic of the Highcross Shopping Centre is its composition of irregular, angular planes that create a sculptural and dynamic metal surface. These fragmented and non-uniform geometries might increase the unpredictability of reflected light paths, intensifying glare and making it harder for observers to visually adapt.

This physical complexity likely contributed to the higher scores for disorientation and discomfort observed in participant responses. In contrast, the Mattioli Woods PLC building has a smoother, more planar glass facade, which produces reflections that are more uniform and visually stable. This design difference supports the study's premise that facade geometry plays a crucial role in shaping psychological and perceptual outcomes. This aligns with findings by [29], who demonstrated that angular reflective curtain walls can intensify glare zones through broader reflection boundaries depending on orientation and solar angle. This aligns with the objective of this study to compare how different reflective materials influence public perception. The results confirm that reflective metal surfaces may induce more stress and discomfort than reflective glass, suggesting that not all reflective materials affect observers equally.

In terms of psychological outcomes, the findings reinforce insights from Winz et al. [9] and St-Jean et al. [5], who argue that overstimulating environments trigger emotional stress responses. Participants in this study reported higher stress and mood disruption when viewing the Highcross shopping centre building, echoing concerns that urban form can be a contributor to emotional distress. Moreover, the impact of familiarity was apparent: permanent Leicester residents reported lower levels of discomfort and stress. This supports adaptation theories in environmental psychology, suggesting that regular exposure may reduce negative reactions to visually stressful stimuli [13].

Despite the low scores given by the participants, suggesting minimal psychological impact from both facades, it should be noted that subjective responses inherently contain variability, as a small number of participants did report elevated stress levels (scores of 4 or 5). This could be explained by variability in subjective lighting evaluations and the fact that populations with visual impairments or neurological sensitivity (e.g., migraine sufferers) may react more strongly to bright, specular surfaces [16].

From a theoretical standpoint, the results substantiate the relationship between built form and psychological well-being. Visual comfort is not only an aesthetic or functional concern but a psychological one with measurable emotional consequences. Reflective facades, particularly those made of metal, create visual conditions that can disrupt attention, strain perception, and elevate stress levels, particularly for newcomers or visitors. Practically, architects and urban designers should be cautious when specifying highly reflective materials. The Mattioli Woods building demonstrates that reflective glass can still provide visual interest without generating the same level of disorientation or discomfort as a metal facade. Material selection should be informed by both aesthetic goals and empirical evidence on psychological comfort. Furthermore, the angular and irregular form of the Highcross shopping centre's facade amplifies reflective intensity through its fragmented geometry. Future facade designs should account not just for surface material but also surface geometry and how it modulates light behaviour. From a policy perspective, planning regulations might benefit from incorporating visual assessments alongside other environmental metrics. As

cities densify, the cumulative impact of reflective materials on the public realm should be considered. Policies could encourage facade strategies that minimise glare, such as using matte or diffuse finishes, restricting concave geometries, or mandating glare assessments in planning applications.

6. Study Limitations

Despite its valuable insights, this study faced several limitations. First, the sample size (N = 30) was smaller than originally planned to comply with the initial G-power analyses (within-factor ANOVA test) for repeated measurements (N = 32), considering one sample group and two conditions (scenarios), assuming an effect size of 0.30 and a power of 0.90. This reduces the generalisability of the findings and increases the possibility of statistical bias. However, this was overcome by conducting a within-subject analysis where the same subject gave feedback on two different reflective facades (metal versus glazing). This helped personal characteristics (e.g., age, intelligence, motivation) that might confound results are held constant.

Second, the use of photographic images instead of in situ observations limited the realism of the visual stimuli. Participants may not have fully experienced the dynamic and context-specific glare effects that occur in real-world conditions. Another limitation was the reliance on self-reported data. Although Likert scales and comparative questions were effective for quantifying subjective experience, they do not capture physiological stress markers (such as cortisol levels) that could have provided a more objective measure of psychological strain. Therefore, future studies should consider the triangulation approaches as a method of cross-validation using physiological measures. Moreover, future investigations should incorporate time-stamped, angle-specific visuals or immersive VR simulations to enhance perceptual validity. Finally, the context-specific nature (e.g., sky illumination, sky coverage, facade orientations) of the case studies means the results may not apply to different cities, climates, or building types. While Leicester represents a moderate urban environment, future studies can explore reflective facade impacts in denser cities, high-rise buildings, or those with different environmental light conditions.

7. Conclusions

The central aim of this research was to investigate how reflective facades influence the visual perception and psychological responses of street pedestrians in urban settings using two case study buildings in Leicester, UK: the Highcross shopping centre building (sharp metal facade) and the Mattioli Woods PLC building (smooth glass facade). Using an online questionnaire incorporating visual stimuli and Likert-scale questions, responses from 30 participants were analysed to determine differences in visual perception and the associated physiological responses. The findings indicate that reflective facades can contribute to varying degrees of visual discomfort and disorientation, depending on the material type and facade geometry. Participants consistently rated the Highcross shopping centre building as less visually comfortable and more disorienting than the Mattioli Woods PLC building, with differences that were statistically significant. This suggests that reflective metal facades with irregular and angular planes may generate more perceptual and emotional challenges, such as disorientation and visual discomfort, which, though not universal, were statistically significant compared to smoother, glazed facades in the study context. While both facades were rated as equally attractive in terms of visual interest, the analysis indicates that both buildings' reflective facades evoke only low levels of perceived stress, tension, or unease, with median scores remaining low overall. The impact on mood or focus was minimal for most respondents, with the metal sharp facade showing a slightly higher perceived effect than the glass soft facade. In general, these findings highlight the

importance of user-centred design, particularly in dense urban settings where facade design may influence outdoor visibility and subjective well-being. As cities adapt to climate challenges, facade materials should be evaluated not only for energy performance but also for their impact on human responses. Balancing these factors is essential for creating truly climate-resilient and liveable urban environments. These findings also reflect the commitment to SDG Goal 11—Sustainable Cities and Communities, target 11.6. 5: 'Reduce the Environmental Impact of Cities'.

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Conflicts of Interest: The authors declare no conflicts of interest.

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