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# Gender-Inclusive Urban Design: Insights from Eye-Tracking Research

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***Abstract:*** *Safety stands as the fundamental and paramount prerequisite for urban livability. The perception of safety significantly influences individuals' quality of life and mental well-being. Elevating personal safety levels, particularly for women who continue to experience safety concerns in modern cities, is imperative. This research delves into the influence of diverse urban facility designs on people's sense of security. Participants were exposed to images portraying distinct street views: one illuminated with ample nighttime lighting, and the other shrouded in darkness with a distant light source. Each image featured indistinct human figures nearby, symbolizing potential safety risks. Participants' gaze patterns, indicative of their visual attention, were recorded using an eye tracker. The eye-tracking data facilitated the acquisition of quantitative results. Data analyses revealed heightened sensitivity to figures in dark scenarios compared to well-lit environments. Females had more need of lighting in both scenarios. Additionally, in darker settings, compared to males, females exhibited more fixation behaviors towards distant light sources, signifying increased anxiety and a proactive effort to seek safety elements to mitigate risks. The underlying reasons for this gender-based difference are discussed. This study underscores the critical need to enhance females' feelings of safety and address the actual safety conditions they encounter. The findings offer insights and guidance for human-centered transformations in urban design, contributing to the creation of a more gender-inclusive society and fostering the well-being of residents, especially women.*

***Keywords:*** *Gender inclusive city, Lighting, Urban design, Urban facility, Eye tracking, Security, Female*

## 1. Introduction

Urban spaces constitute vital components of society. Personal safety plays a pivotal role in enhancing the well-being and quality of people's lives. Improving citizens' perception of personal safety is a crucial prerequisite for fortifying the vibrancy of urban public spaces[1]. While urban development has reached a high level of maturity, potential safety hazards for citizens, particularly women, still persist. Historically, urban designs and facilities have lacked consideration for the female perspective, resulting in cities that primarily cater to male needs. Female citizens consistently encounter various inconveniences and unsafe situations[2]. Both physical and psychological differences render women more susceptible to a range of safety-related challenges within urban environments compared to men [3]. Disparities in body shape and strength further contribute to women's vulnerability in unsafe scenarios [4][5]. The Gender-Inclusive Urban Planning Handbook published by the World Bank[6] highlights the deficiency of adequate lighting in public spaces, which often leaves females feeling more uncomfortable and insecure. Numerous studies confirm that women's behavior and daily activities are often influenced by the fear of sexual violence or street crime occurring at night[7]. This fear of victimization restricts women from accessing specific times and certain public areas[8]. A lack of trust in urban spaces significantly diminishes women's enthusiasm for participating in urban public life and their overall well-being. Therefore, it is imperative to incorporate gender factors into urban design and planning, while addressing the construction and reconstruction of urban public spaces from the standpoint of female safety and Inclusivity.

Many studies have examined the correlation between urban safety facilities and the security of women during nighttime travel. Rahman's research underscored the significance of streetlights in enhancing the mobility of females, reducing their apprehension of traveling alone in the dark, and thereby promoting increased mobility among women overall[9]. Following interviews, observations, surveys, and discussions, a research team in the Omugo extension camp, Uganda, also determined that women are less inclined to utilize public infrastructure in poorly lit areas after dark due to fears of gender-based violence[10]. However, most of these studies relied on questionnaires, interviews, and other qualitative

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methods. This study aims to quantify the relationship between safe factors, risks, and people's responsive behaviors. Participants will examine images of street views presenting various scenarios. An eye-tracking device will be integrated into the study to record the subjects browsing process. An eye tracker can capture individuals' gaze behavior and patterns, which reflect their corresponding visual attention. Furthermore, the data from an eye tracker can provide numerical information, enabling the quantification of people's behaviors. The objective and precise results could significantly support people's responses to different scenarios and facilities. Simultaneously, a gender-based investigation will be conducted. The findings could provide up to date results and have the potential to offer insights for enhancing urban planning and design, particularly in optimizing humanized facilities and public spaces for females. This could enhance the quality of public life and contribute to the creation of a more livable city.

## 2. Methods

### *2.1. Participants*

In this study, the sample comprised 27 randomly selected participants (Mean Age = 32.55, Standard Deviation = 13.64) from Shanghai, China, including 13 males and 14 females. The participants were provided with information about the device, procedures, and potential risks associated with the experiment in advance. All of them volunteered to participate in the experiment and signed the informed consent form before the commencement of the study.

### *2.2. Stimuli*

This experiment utilized four images of urban nighttime street views to serve as stimuli. Two of these images depicted relatively well-lit street scenes with bright light sources at night (referred to as B1 and B2). The other two images portrayed comparatively dark streets with dim light sources in the distance (referred to as D1 and D2). In comparison to the well-lit environments, the dark images were more likely to evoke feelings of unsafety. Additionally, each image included indistinct human figures, symbolizing potential risks. Notably, there were no other pedestrians present in the images.

### *2.3. Design and Procedure*

The study employed a within-subjects design. Participants were asked to sign the consent form and were seated in front of a screen equipped with an eye-tracking device (Tobii 4C). Each participant underwent a nine-point calibration procedure before the experiment to ensure the proper functioning of the eye tracker. Following the successful calibration, the subjects entered the formal experimental phase. Several instructional slides were presented initially to provide an overview of the task and scenario. These slides informed the participants that they would be simulating walking home alone at night, and they were required to navigate through the upcoming streets. Additionally, participants were provided with noise-canceling headsets that played the sound of footsteps to enhance the immersive experience.

Subsequently, the four images (B1, B2, D1, and D2) were displayed in sequence, with each image presented for 15 seconds. An eye-tracker recorded their gaze patterns throughout this process. After viewing the images, a post-trial survey was administered to gauge participants' feelings in dark scenarios.

The entire experiment lasted approximately five to ten minutes, and participants received gifts as a gesture of thanks.

The areas of interest (AOIs) within the four photos were categorized into two groups: "Human Figure" and "Light." Eye tracking parameters, including total fixation duration (TFD) and fixation count (FC), within each AOI were collected to quantify visual attention.

### *2.4. Data Analysis*

In order to compare participants' gaze behavior within each Area of Interest (AOI), t-tests were conducted for both Total Fixation Duration (TFD) and Fixation Count (FC) across all participants. Additionally, to investigate potential gender differences, within-group and between-group t-tests were performed for both male and female participants.

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## 3. Results

### *3.1. T-test Analyses on TFD and FC of Human Figure in Bright and Dark Scenarios*

As indicated in Table 1, the T-test results revealed a significant difference (t=1.68, p<0.05) in Total Fixation Duration (TFD) when observing Human Figure between bright (M=2.03, SD=1.43) and dark environments (M=3.56, SD=2.41). The results of Fixation Count (FC) also showed a significant difference (t=1.68, p<0.05) between bright (M-bright=5.44, SD-bright=2.85) and dark (M-dark=7.65, SD-dark=4.12) environments.

### *3.2. T-test Analyses on TFD and FC of Light in Bright and Dark Environments*

The results are presented in Table 1. There is a statistically significant difference (t=1.68, p<0.05) in Total Fixation Duration (TFD) for Light between bright (M=0.98, SD=0.67) and dark (M=0.59, SD=0.54) environments. Additionally, analyses of Fixation Count (FC) showed no statistically significant difference (t=1.68, p>0.05) (M-bright=2.15, SD-bright=1.74; M-dark=1.72, SD-dark=1.49).

*Table 1: The TFD and FC of All Participants.*

| | TFD (s) | | FC | |
|---|---|---|---|---|
| | Bright | Dark | Bright | Dark |
| Human Figure | 4.20 | 7.39 | 11.15 | 15.85 |
| Light | 0.98 | 0.59 | 2.15 | 1.72 |

### *3.3. T-test analyses on TFD and FC of Human Figure in bright and dark environments within females and males*

According to Table 2, males (M-bright=1.95, SD-bright=1.30, M-dark=2.95, SD-dark=1.96) and females (M-bright=2.11, SD-bright=1.62, M-dark=4.22, SD-dark=2.75) both show statistical differences (t-male=1.72, t-female =1.73 p-male<0.05, p-female<0.05) in TFD regarding Human Figure in two different environments. The results of FC revealed no significant difference for males (t =1.72, p>0.05), while females on the opposite (t=1.71, p<0.05).

*Table 2:The TFD and FC for Human Figure of Males and Females.*

| | TFD (s) | | FC | |
|---|---|---|---|---|
| | Bright | Dark | Bright | Dark |
| Males | 1.95 | 2.95 | 5.21 | 7.01 |
| Females | 2.11 | 4.22 | 5.69 | 8.27 |

### *3.4. T-test analyses on TFD and FC of Light in bright and dark environments within males and females*

The results are recorded in Table 3. Males exhibit a statistical difference (t=1.76, p<0.05) in TFD between bright (M-bright=2.17, SD-bright=1.64) and dark (M-dark=0.41, SD-dark=0.34) scenarios. In opposite, females showed no significant difference (t=1.72, p>0.05) for TFD of Light between bright (M-bright=0.89, SD-bright=0.86) and dark (M-dark=0.78, SD-dark=0.65) scenarios. Both males (M-bright=2.21, SD-bright=1.54, M-dark=1.36, SD-dark=1.17) and females (M-bright=2.08, SD-bright=1.99, M-dark=1.12, SD-dark=1.73) have no significant difference (t-male=1.72, p-male>0.05, t-female=1.72, p-female>0.05) in regard to FC.

*Table 3: The TFD and FC for Light of Males and Females.*

| | TFD (s) | | FC | |
|---|---|---|---|---|
| | Bright | Dark | Bright | Dark |
| Males | 1.06 | 0.41 | 2.21 | 1.36 |
| Females | 0.89 | 0.78 | 2.08 | 2.12 |

### *3.5. T-test Analyses on TFD and FC of Human Figure in Bright and Dark Environments between Males and Females*

The results of the participants are presented in Table 2. In Total Fixation Duration (TFD) for the Human Figure, there is no significant difference (t-bright = 1.71, p > 0.05; t-dark = 1.72, p > 0.05)

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between males (M-bright=1.95, SD-bright=1.30, M-dark=2.95, SD-dark=1.96) and females (M-bright=2.11, SD-bright=1.62, M-dark=4.22, SD-dark=2.75) when observing figures in both bright and dark environments. As for Fixation Count (FC) for the human figure, males (M-bright=5.21, SD-bright=2.35, M-dark=7.01, SD-dark=3.39) and females (M-bright=5.69, SD-bright=9.57, M-dark=8.27, SD-dark=7.60) do not significantly differ from each other (t-bright=1.72, $p > 0.05$; t-dark=1.71, $p > 0.05$) in both bright and dark circumstances.

### *3.6. T-Test Analyses on TFD and FC of Light in Bright and Dark Environments between Males and Females*

The results are presented in Table 3. There is no significant difference (t-TFD = 1.73, p-TFD > 0.05; t-FC = 1.71, p-FC > 0.05) between males (M-male=1.06, SD-male=0.51; M-male=2.21, SD-male=1.54) and females (M-female=0.89, SD-female=0.87; M-female=2.08, SD-female=1.99) when they are viewing light in a bright environment, in terms of both TFD and FC. However, in a dark environment, TFD exhibits a statistically significant difference ($t=1.73$, $p < 0.05$) between males (M=0.41, SD=0.34) and females (M=0.78, SD=0.65), while FC (M-male=1.36, SD-male=1.17, M-female=2.12, SD-female=1.73) remains statistically insignificant ($t=1.72$, $p > 0.05$).

## 4. Discussion

This research aims to investigate people's responses to safe and unsafe factors in various urban scenarios, with a particular focus on gender differences. Four images depicting urban street views at night were used as stimuli. Two of these images feature comparatively bright scenes with sufficient light sources, while the other two showcase relatively darker views with dim lighting. Each image includes safety elements, such as lights, as well as potential risks, such as indistinct human figures. Participants were informed that they were tasked with walking home alone at night, and the four images were presented on the screen in the sequence of two bright street views and two dark street views. The subjects' gaze patterns were recorded using an eye tracker to quantify their visual attention. Data analysis revealed that both male and female participants paid significantly more attention to human figures in both bright and dark environments. This suggests that people are sensitive to potential unsafe factors when navigating at night. Males demonstrated a higher level of gaze directed at lights in bright environments but paid less attention to lights in dark environments. In contrast, women showed equal attention to lights in both bright and dark environments. When compared to males, females exhibited statistically significant increases in total fixation duration and fixation counts on lights in dark environments. In the post-trial survey, the majority of males indicated that they were not fearful of the vague human figures that were displayed.

Both male and female subjects exhibited heightened attention to human figures in dark environments. This phenomenon can be attributed to the fact that people associate the presence of human figures in the darkness with potential risks, such as robbery, murder, or other forms of violence. The nighttime, particularly in dark settings, is known for its elevated crime rates. According to the 2017 Open City Crime Report[11], 65 percent of murder/negligent manslaughter cases and 56 percent of robberies occurred between 7 p.m. and 6:59 a.m. As a result, both men and women tend to be more sensitive and alert in such dark environments. This finding aligns with the conclusions drawn in previous studies. Yu and Ruan[12] suggested that both women and men are able to identify potential risks similarly. Likewise, a social security survey found that when rating security risks, there was no significant difference between women’s and men’s feedbacks[13].

In low-light conditions, women exhibited significantly longer total fixation duration and more fixation counts to light sources compared to men. This suggests that women have a greater inclination to prioritize safety factors and safety facilities in potentially unsafe environments as compared to males. Salmani's study posits that obstructive elements such as trees that impede sight and light have a more pronounced impact on women's feelings of insecurity. This heightened insecurity can lead to increased fear and a heightened perception of crime and violence among women[14]. Consequently, proper lighting becomes particularly crucial for enhancing women's sense of security. Additional research indicates the existence of significant gender differences in risk perception[15] . From an instinctive theory perspective, Cheng et al.argue that females tend to experience higher levels of state anxiety than males due to differences in brain structure. In terms of behaviors, societal stereotypes labeling women as weaker and in need of protection increase their susceptibility to becoming victims, contributing to heightened fear in environments with potential safety concerns[16] . Notably, a significant proportion of rape cases primarily

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target females during nighttime hours. According to a report by the Bureau of Justice Statistics, two-thirds of all rapes and attempted rapes occur at night, with the majority happening between 6 p.m. and midnight[17]. This elevated incidence of crime further exacerbates women's feelings of insecurity in dark environments. As a result, women tend to seek out factors such as adequate lighting and security cameras to enhance their overall sense of security, whether in well-lit or dimly lit environments.

Moreover, females displayed an equal level of attention to safety factors in both dark and well-lit environments. This suggests that, not only in dark environments, women have a strong need for safety during nighttime. On the other hand, males paid more attention to human figures in both bright and dark environments, but they paid less attention to the safety factor, specifically lights, in dark environments. This indicates that males are vigilant about potential risks, while they are relatively less anxious. The reason why males paid more attention to lights in well-lit environments is that they are comparatively more relaxed though they can sense the risks. This allows them to allocate their attention to observe their surroundings. Objects are clearer in proximity to light sources. Therefore, males exhibit more fixation behaviors towards lights in well-lit environments.

Future research endeavors could explore more directions to make the findings more comprehensive. Previous research has indicated that various factors, such as geographic location, education level, income, and age, significantly influence women's sense of security[18]. Given these findings, future studies should aim to refine their classification criteria and incorporate additional variables when analyzing experimental data. Additionally, while this study focuses on lighting as a safety factor, it would be worthwhile to investigate the impact of other facilities or measures, such as security cameras, security kiosks, or police lights, on women's sense of security.

## 5. Conclusion

This study delved into individuals' responses to safe and unsafe elements in various scenarios. Participants were presented with a series of images depicting nighttime urban street scenes and their gaze behavior, reflecting their attention, was tracked using an eye-tracking device. The quantitative eye-tracking results revealed that both genders tend to pay more attention to potential risks at night. However, in low-light conditions, females displayed a stronger fixation on light sources compared to males, underscoring the significance of lighting conditions for women's sense of security. Moreover, females pay equal to lights in both will-lit and dark environments which indicates Women possess a significant requirement for safety during nighttime in both will-lit and dark environments. These findings provide compelling evidence that nowadays women have a heightened need for safety measures in dark environments. In future urban planning and design, it is imperative to incorporate additional safety features such as adequate lighting in public spaces. This approach not only contributes to a more gender-inclusive society but also enhances the overall well-being of female residents.

## References

*[1] Huang Dengkai, Wang Guoguang, & Chen Zhiyun. (2020). Study on the influence of students in Guangzhou University Town. Southern Architecture (4), 7.*
*[2] Favro D, Weisman L K. (1994). Discrimination by Design: A Feminist Critique of the Man-Made Environment. 81(2), 834.*
*[3] Momeni M, Rostami S. (2016). Organization of Urban Spaces with Emphasis on Women's Safety: A Case Study in Noor Abad Mamasani, Iran. Cities.*
*[4] Greed, C. (2019). Are we still not there yet? Moving further along the gender highway. Integrating gender into transport planning: From one to many tracks, 25-42.*
*[5] Uteng, P. T., & Turner, J. (2019). Addressing the Linkages between Gender and Transport in Low- and Middle-Income Countries. Sustainability, 11(17), 4555.*
*[6] Terraza, H., Orlando, M. B., Lakovits, C., Lopes Janik, V., & Kalashyan, A. (2020). Handbook for gender-inclusive urban planning and design.*
*[7] Boomsma, C., & Steg, L. (2014). Feeling safe in the dark: Examining the effect of entrapment, lighting levels, and gender on feelings of safety and lighting policy acceptability. Environment and Behavior, 46(2), 193-212.*
*[8] Teng, J. R. (2014). Feminist architectural theory. Beijing: China State Engineering and Construction Press.*
*[9] Rahman, L., & Rao, V. (2004). The determinants of gender equity in India: examining Dyson and Moore's thesis with new data. Population and Development Review, 30(2), 239-268.*

ISSN 2616-5783 Vol.6, Issue 24: 113-118, DOI: 10.25236/AJHSS.2023.062419

*[10] Fisher, J., Reed, B., Vidal, J., Sissons, C., Lafreniere, J., & Hastie, R. (2018). Lighting the Way: Lighting, sanitation and the risk of gender-based violence.*
*[11] Violent crime. (2018). FBI. Available at: https://ucr.fbi.gov/crime-in-the-u.s/2017/crime-in-the-u.s.-2017/topic-pages/violent-crime (Accessed: October 17, 2023).*
*[12] Wei, J., & Ruan, M. (2011). An empirical study on the sense of security of Chinese urban residents — based on surveys in three cities: Beijing, Zhengzhou, and Kunming. Journal of Beijing University of Technology: Social Sciences Edition, 11(6), 8.*
*[13] Lu Guoxian. (2017). Influencing factors and urban security countermeasures —— Take Taizhou as an example. Journal of People's Public Security University of China (Social Science Edition), 2017 (4).*
*[14] Salmani, A., Saberian, O., Amiri, H., Bastami, M., & Shemshad, M. (2015). Study on urban parks Environmental safety in Women Viewpoints based on Crime Prevention through Environmental Design Approach (Case study: Valiasar Park, Shahr-e-Qods, Tehran, Iran).*
*[15] Shen, M., & Wang, Y. (2022). Gender differences in individual characteristics, income level, and policing risk perception — based on an empirical study in 460 communities. Chinese Administration, 1(9).*
*[16] Wu, L., & Cheng, Y. (2015). Interpretation of gender difference in public space: based on the theoretical perspective of integration. Human Geography, 30(1), 5.*
*[17] Klaus, Patsy A. "The Crime of Rape." Bureau of Justice Statistics, bjs.ojp.gov/library/publications/crime-rape-0. Accessed 14 Nov. 2023.*
*[18] Ren, D. (2019). Research on the optimization of walking space around large commercial buildings based on women's sense of security (Master's Thesis, Harbin Institute of Technology). https://43.138.60.40/KCMS/detail/detail.aspx?dbname=CMFD202001&filename=1019648323.nh*