“In the evening, I don’t walk in the park”: The interplay between street lighting and greenery in perceived safety

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Abstract

Walking as a means of transportation is a key feature in sustainable urban design, but few studies have examined the influence of micro-level environmental features, such as vegetation and street lighting, on perceived safety and people’s choice to walk. This study applied a non-explicit approach to examine the relationship between greenery, street lighting, perceived safety, and walking in an urban context. Participants from three neighbourhoods in Malmö, Sweden, took part in focus group discussions concerning neighbourhood qualities related to walking.

A qualitative analysis revealed four inter-related themes relevant for perceived safety after dark: avoidance, entrapment, presence of others, and prospect (visual overview of the nearby surroundings). The quality of urban greenery and street lighting impacted people’s route choices after dark, and some participants felt compelled to make detours. Entrapment, partly due to unkempt greenery in combination with darkness, contributed to avoidance, whereas the presence of other people had the opposite effect. The results indicate that urban greenery and street lighting must be considered together, since their interaction influences perceived safety and impacts the walkability of the neighbourhood.

Keywords Focus group study · Mobility · Pedestrian · Street lighting · Vegetation · Walking

Introduction

One important consideration in sustainable urban design is the pedestrian. Walking is a sustainable form of transportation that contributes to healthy living conditions on the local level (Wilson et al. 2007; Xia et al. 2015) and benefits public health. Research has considered the impact of meso-level built environment characteristics (such as density, diversity, and design of the built environment) on people’s travel mode choices and their level of physical activity (Ewing and Cervero 2010; Badland and Schofield 2005). However, little research has addressed the influence of people’s perception of micro-level environmental features, such as vegetation and street lighting, and how these features may interact in

influencing the choice to walk as a means of transportation in urban environments (Kim et al. 2014; Park et al. 2015).

Greenery is a valuable part of the urban landscape, with functions important for human well-being (Russell et al. 2013; Konijnendijk et al. 2013; Hartig et al. 2014), such as offering opportunities for physical activity and recreation (Kaczynski and Henderson 2007) and potential for restoration (Hartig et al. 2003). Green spaces with species diversity that offer a place of refuge and the experience of being in nature afford optimal restoration potential for stressed individuals (Grahn and Stigsdotter 2010). Green, open spaces in a neighbourhood encourage elderly people to walk for both leisure and as a mode of transport (Sugiyama and Ward Thompson 2008).

In the Nordic context (and in other countries at high latitudes), daylight hours are very limited for much of the year. The urban environment is perceived differently after dark, and pedestrians depend on outdoor lighting to ensure functional levels of visual accessibility and perceived safety when walking. Lack of, or insufficient, artificial outdoor lighting may turn environments that are inviting during the day into intimidating places avoided after dark (Yeoh and Yeow 1997; Nasar and Fisher 1993; Crewe 2001). Some

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studies have touched on the interplay between urban greenery and outdoor lighting in terms of the potential for restoration after dark (Nikunen and Korpela 2009, 2012; Nikunen et al. 2014), but few studies have examined the role of the interaction between greenery and outdoor lighting in how a pedestrian perceives safety.

The literature suggests that urban greenery and street lighting affect the perceived safety of the environment (Jansson et al. 2013; Maas et al. 2009; Boomsma and Steg 2014; Sreetheran and van den Bosch 2014; Özhanci et al. 2014; Johansson et al. 2011). This, in turn, is linked to how much the urban environment is used for walking (Hong and Chen 2014; Foster et al. 2013; Tiwari 2015).

This study aims to cast light on the relationship between greenery, street lighting, perceived safety, and walking in an urban context. The study was part of a multi-disciplinary research project relating to walking and the urban environment, and involved researchers specialised in architecture, traffic safety, and environmental psychology. Focus group discussions concerning neighbourhood qualities in relation to walking were held on site in semi-central neighbourhoods during daylight hours. In these discussions, participants frequently and unprompted talked about their perception of safety and how this is connected to urban greenery and street lighting.

Theoretical background

The idea that the perception of safety is influenced by the physical environment may be understood from the perspective of human–environment interaction. The Human Environment Interaction (HEI) model (Küller 1991) is a framework for understanding the transactions between the individual and the social and physical environment. According to the HEI model, the individual's perception of safety at any given moment is influenced by perceptions of both the social and the physical environment, as well as by individual traits and experiences.

A more specific approach to examining the impact of greenery and lighting on the perception of safety involves an adaptation of the prospect-refuge theory (Appleton 1975). A modified version of the theory (Fisher and Nasar 1992) considers the influence of environmental factors on the perception of safety in urban areas. It argues that people perceive places as less safe if the environment provides potential hiding places for criminals (refuge), while limiting the pedestrian's overview of the nearby surroundings (prospect) and the possibilities for escaping an unsafe situation.

While the prospect-refuge theory focuses on the physical environment, the social–psychological model of fear of crime (van der Wurff et al. 1989) considers both the physical and social environment. This model attributes fear of crime to four psychological factors—attractivity, evil intent, power,

and criminalisable space. Attractivity concerns the extent to which people see themselves or their belongings as an attractive target for crime. Evil intent concerns the extent to which people attribute criminal intentions to others, and power describes the degree to which people believe they can deal with a threat or an assault by a criminal. Criminalisable space emphasises place, time, and the presence of others as factors describing the extent to which an individual perceives a situation as supporting criminal activity.

To date, research on the impact of urban greenery on perceived safety has focused on landscape design, vegetation density, vegetation character, and maintenance (for reviews, see Jansson et al. 2013; Sreetheran and van den Bosch 2014). Studies investigating the importance of outdoor lighting for perceived safety after dark have either focused on differences in brightness due to spectral differences between light sources (Knight 2010; Painter 1996), or applied variations of the prospect-refuge theory by treating lighting as a factor impacting the experience of prospect and refuge in the environment (Blöbaum and Hunecke 2005; Boomsma and Steg 2014; Haans and de Kort 2012).

Previous research has explicitly asked participants about their perceived safety or fear in relation to outdoor environments (see, for example, Fisher and May 2009; James and Embrey 2001; Loewen et al. 1993; Nasar et al. 1993; Nasar and Jones 1997). Although an efficient way of collecting data, this may inadvertently steer the participants' responses in a certain direction, narrowing the response variation and missing out on unexpected experiences. Fotios et al. (2015) used an alternative approach when investigating the impact of outdoor lighting on pedestrian reassurance (defined as encompassing both perceived safety and fear of crime) after dark. Without emphasising lighting or using words alluding to safety or fear, the researchers asked participants to identify characteristics of streets where they would feel, or not feel, confident about walking after dark. The interviews were divided into two parts: general discussions about factors that made people feel confident about walking on streets after dark, and a more focused interview using pictures of streets as visual prompts for discussion. The results from both parts showed the importance of street lighting in pedestrians feeling reassured.

Using the same rationale as Fotios et al. (2015), but in a real-world setting known to the participants, this study applies a non-explicit approach to explore how urban greenery and outdoor lighting affect the perception of safety, with no prompting of the participants about the topic. A further aim is to investigate how the perception of safety affects how the participants use the neighbourhood for walking.

Method

Participants and settings

The study involved 106 participants aged 18–84 years, 51% of whom were female. Participants were recruited through a questionnaire study on daily travel and walking behaviour, completed one year earlier, in which they had expressed interest in participating in future studies (Lindelöw et al. 2014). The participants lived in one of three neighbourhoods: Rönneholm ($N=38$, 58% female, mean age 50 years, range 18–84 years), Dammfri ($N=40$, 52% female, mean age 51 years, range 26–84 years), or Lorensborg ($N=28$, 39% female, mean age 63 years, range 26–84 years), located in semi-central Malmö (about 300,000 inhabitants), Sweden (Figs. 1, 2, 3, 4, 5).

The neighbourhoods are considered ordinary, non-landmark residential areas with mid-twentieth-century design, without any important urban magnets of their own. However, all three neighbourhoods are located within walking distance of municipal parks, public transport, and shopping facilities. Their building typologies vary: Rönneholm consists of 4–6-storey closed grid blocks and semi-open building blocks, Dammfri has early modern blocks with 4–6-storey free-standing residential buildings lining the streets, while Lorensborg comprises modern superblocks

with 8-storey residential buildings and lower buildings facing adjacent streets. The vegetation is mainly concentrated in large and medium-sized parks containing trees, bushes, and grass, but there are also fragmented patches of greenery located within the densely built residential areas (Malmö 2003).

Traffic planning of the neighbourhoods differs in terms of street network layout (Rönneholm: integrated, Dammfri: semi-integrated; Lorensborg: segregated), and the neighbourhoods offer different types of walking environments. The neighbourhoods are located in a part of Malmö where the crime rate is lower than the average for the city, as well as lower than average compared to other major Swedish cities (Swedish National Council for Crime Prevention 2018). The pedestrian areas of the neighbourhoods are lit by high-pressure sodium lights (Rönneholm, Correlated Colour Temperature, CCT: 2060 K), ceramic metal halide lights (Dammfri, CCT: 2821 K), and LED lights (Lorensborg, CCT: 4098 K).

Procedure

In each district, the participants first took part in a structured 300-m walk representative of the pedestrian planning strategy of the district, with on-site assessments at place-specific stops (Johansson et al. 2016, 2019). The structured walks served to focus the participants' attention on

Fig. 1 Map of Malmö. 2018 Source: Lantmäteriet (2018)

Fig. 2 Close-up map of Malmö showing the three neighbourhoods: Rönneholm, Dammfri, and Lorensborg. 2018 Source: Lantmäteriet (2018)

Fig. 3 Part of the path in Rönneholm

Fig. 4 Part of the path in Dammfri

Fig. 5 Part of the path in Lorensborg

the built environment encountered while walking (results reported in Johansson et al. 2016). The walks were conducted during the afternoons and early evenings (before twilight) in August and September, during mild weather conditions.

Immediately after the structured walk, the participants gathered for focus group discussions. A researcher led these discussions, using a semi-structured interview guide containing open questions about the qualities of the neighbourhood and invitations to suggest how to improve the neighbourhood in relation to walking (see Table 1). The interview questions were used as prompts for stimulating the focus group discussions. The groups were kept small (approximately four participants in each group) to extract as much unique information as possible (Fern 2001). The participants could speak freely, and the discussions covered a variety of topics relating to the pedestrian experience. Twenty-four focus group discussions were held, each taking

Table 1 Interview questions used to stimulate discussions in the focus groups

What are your impressions of the route, as pedestrians?
Did you notice anything particularly good or bad?
Is there anything that could be improved to make it better for transport walking? If so, what?
Are there any particularly pleasant or unpleasant passages in this area?

approximately 15 min. The overall procedure lasted between one and 2 h.

The study complied with the rules and regulations laid down by the Ethics Committee for the Swedish Research Council (Gustafsson et al. 2011). All participants were informed about the overarching aim of the study, i.e. to explore how the participants perceived their neighbourhood with regard to walking for transport (without mentioning specific neighbourhood qualities related to walking), and about their right to withdraw at any time without giving an explanation. Participants provided written informed consent in accordance with the Declaration of Helsinki, and personal information was anonymised to retain the privacy of the participants.

Analysis

The focus group discussions were recorded, transcribed and imported into Atlas.TI 7. Based on a sample of 12 interviews, the first author conducted an initial coding on a line-by-line basis. All three authors then collaborated to discuss the codes and refine the code list, and the first author recoded four interviews using the refined code list. After a final review, the code list was completed, and the first author coded all 24 interviews.

The coded transcripts of the focus group discussions revealed recurring comments about vegetation and lighting in relation to safety (greenery was mentioned 211 times, lighting 90 times, and safety 121 times). The authors then decided to focus on these three topics in the analysis conducted for this article.

The first and third authors' coding was compared for four interviews, to estimate interrater reliability. In line with suggestions by Campbell et al. (2013), the overall interrater reliability was determined by dividing the number of agreements with the total number of coded sentences, for all three codes. Greenery, lighting conditions and perceived safety were coded 69 (24 + 18 + 27) times in agreement out of the total of 74 (25 + 20 + 29) coded sentences, giving an interrater reliability of 0.93.

The Atlas.TI query tool was used to identify the parts of the interviews in which lighting or greenery was discussed in relation to perceived safety, and lighting discussed in relation to the appearance of urban greenery after dark. The tool identified greenery and safety 15 times, lighting and greenery 22 times, and lighting and safety 43 times.

The paragraphs in which the codes co-occurred were compiled into a new document. Co-occurrence was defined as the coded sentences being within 100 words of one another, independent of order. The distance between words was chosen through an iterative process, using both greater and shorter distances, and was found to capture relevant quotations while excluding unrelated information.

The quotations in the document were analysed for similarities and differences, and the three authors in collaboration categorised the quotations in themes. The quotations were then translated into English by a professional translator and validated by the first author.

Results and discussion

Four clear themes were identified in the compiled quotations from the co-occurring codes. A common theme found for greenery and lighting was the **avoidance** of certain areas after dark. Participants regarded greenery as a positive environmental factor during the daytime, but frequently reported that they avoided environments with greenery (especially the municipal parks) after dark:

It's very dark in there. I wouldn't recommend people to go there in the middle of the night. (Participant #02, male, interview B)

I wouldn't like to go through Rönneholms Park at night, I just don't do it. Then I'd prefer to go between. No, it's still dark and forbidding there in fact. (Participant #04, female, interview D)

Then I feel very unsafe in the park. It's dark and, as I said, people don't like to go out after it gets dark. (Participant #10, female, interview I)

To a certain extent, I agree that this is green and attractive. But I feel more like you, that I would never go here when it's dark in the evening. (Participant #01, female, interview A)

Inadequate streetlighting seemed to reinforce the tendency to avoid the municipal parks after dark:

And then there's actually no lighting on a long stretch of it [the route through the park] there. And I've heard many people say that they absolutely wouldn't dare to go out when it's dark in that direction. (Participant #03, female, interview C)

But there is a section there [in the park] where you can walk anyway, where there's no lighting at all. I perhaps

avoid walking there when it's dark. (Participant #05, female, interview E)

The avoidance of certain environments after dark, and the shift in how greenery is perceived when it gets dark, corresponds with research findings from a number of countries, such as Australia (James and Embrey 2001), Japan (Yokohari et al. 2006), Malaysia (Mani et al. 2012), Norway (Skår 2010), Singapore (Yeoh and Yeow 1997), the UK (Madge 1997), and the US (Crewe 2001). The results also correspond with the social-psychological model of fear of crime, which suggests that, at certain times, physical and social environmental factors interact and make a place seem unsafe and preferably avoided, while at other times the factors are not aligned in a way that would trigger avoidance.

An effect of the avoidance behaviour expressed in the interviews was that municipal parks switched from functioning as assets during the day to becoming obstacles after sunset. For some participants, the avoidance meant minor route changes, while others chose another mode of transportation and/or used busier roads:

But in the evening, I don't walk in the park there, but then you can walk over the road so it's still a bit of a half-park, so you've nevertheless got some trees and grass and suchlike. (Participant #08, female, interview A)

Late in the evening I'd rather drive or cycle on Mariedal [main road] than here. Because it's. Erm, I do that. It's dark too. (Participant #06, female, interview F)

Since the municipal parks are quite extensive, some inhabitants had to make significant detours. This may reduce the attractiveness of the neighbourhood for walking and have some consequences for people's use of the environment after dark and on their choice to walk as a means of transportation.

A second theme was the feeling of **entrapment**, i.e. not being able to escape from a potentially dangerous situation, which was associated with feeling unsafe. If the greenery was dense and too close to the path, participants felt that this contributed to the feeling of entrapment:

Above all, here's a fence, so you've got nowhere to go if it's congested or if you meet a cyclist or pedestrian. In the other section, there's a bit more room to move to the side. That's almost what I feel is worst about this section, that there's a fence and hedge on both sides. So, there's nowhere to go. In the evening too, it feels a bit unsafe too. I don't usually walk there in the evenings. (Participant #12, female, interview G)

Participants also mentioned entrapment as a reason for avoiding certain areas after dark. The participants felt trapped, explaining that they lacked an escape route if something were to happen, which reduced feelings of safety:

Then I feel that this stretch, the last bit, it's not a stretch where I'd choose to walk on my own when it's dark. Then I take other routes where it's more, just that it feels that you

can't get away anywhere if I ended up in an unsafe situation. So, I've walked once or twice on my own when it was dark and evening, but I wouldn't do it again. (Participant #11, female, interview E)

Narrow and dark. I don't know, I feel mostly unsafe. If it's late in the evening, 11 or midnight, I'm not so interested in walking here. (Participant #13, female, interview H)

Entrapment is a factor of the adapted prospect-refuge theory, and our results support previous findings of the negative effect of entrapment on perception of safety (e.g. Nasar et al. 1993; Blöbaum and Hunecke 2005; Boomsma and Steg 2014). When an individual perceives an environment as having a high level of entrapment, lighting conditions become less important for the perception of safety, while the level of prospect gains importance (Blöbaum and Hunecke 2005). This may be because a blocked prospect can conceal dangers that would be hard to escape from while the pedestrian is entrapped in the environment. In the focus groups, participants discussed the need for increased prospect in relation to the stretches where they felt entrapped.

Participants did not only avoid the municipal parks; passages with mesh fences and dense greenery close to the path created a sense of entrapment which, in turn, deterred pedestrians from using them after dark. An important note here is that, in the neighbourhoods of our study, some of the paths with dense greenery are the only option for walking in a certain direction, and avoiding them would compel some pedestrians to make lengthy detours.

A third theme was the **presence of others**, which contributed to the perceived safety and also seemed to keep environments inviting after dark. The participants highlighted the presence of others, both on the streets and at outdoor cafés, as contributing to perceived safety:

But I don't feel unsafe there, where there are other people walking dogs and it's lit up and there's more people moving about. (Participant #08, female, interview A)

That there are people out and about, and at the outdoor cafés and bars, and you don't feel alone or frightened there really. Perhaps when it's a bit dark, but not otherwise. (Participant #14, female, interview J)

This is in line with findings from studies on a university campus in Columbus, US (Nasar and Jones 1997) and from the streets of Sheffield, UK (Fotios et al. 2015). A possible argument is that there is potential for a positive feedback loop, where an improved local environment may increase the number of pedestrians, which in turn may increase the perceived safety of the environment and make it even more inviting for pedestrian use (see Foster et al. 2010). The presence of others affects the criminalisable space factor of the social-psychological model of fear of crime (van der Wurff et al. 1989) and, along with the environmental context and the time of day, the presence of others determines whether the environment is considered criminalisable and unsafe.

Naser and Fisher (1993) suggested that the presence of others also reduced the feeling of entrapment, by offering the opportunity of getting help from others if necessary.

Finally, as expected from the prospect-refuge theory (e.g. Appleton 1975; Naser et al. 1993), quotations relating to **prospect** were identified for both lighting and greenery in relation to perceived safety. Participants expressed that greenery could be a concern, with neglected upkeep resulting in large bushes and excessive undergrowth obstructing the views of pedestrians:

The bushes are really... perhaps they should be cut or maintained. Because you don't see each other. Just the fence three metres high is enough, and then there's the bushes too. And the vegetation doesn't add anything positive, I don't think. It feels just neglected actually. (Participant #15, female, interview K)

But if the fence and the hedge had been taken away on both sides, I think the footpath and cycle path would have been perceived in a completely different way. (Participant #02, male, interview B)

For lighting, the participants stated that reasons for concern relating to overview were low levels of lighting and unlit areas:

It's become much better since they did a bit to the lighting there. And because so many trees have also been cut down, it's open in a completely different way. (Participant #16, female, interview B)

Earlier, a lot could be going on behind the bushes, whatever could be going on there. But everything's been cleared up, they've installed lighting, you feel safer when you walk here. (Participant #04, female, interview D)

The results indicate the complexity of pedestrians' perception of safety and show that, after dark, perceived safety

is influenced by both by urban greenery and street lighting. Also, the themes seem to be inter-related, at least to some degree (see Fig. 6). Urban greenery and outdoor lighting may affect each other directly—greenery may obscure luminaires and shade the environment, and outdoor lighting makes the greenery visible after dark. The discussions revealed that greenery and lighting also affected the level of prospect and whether a pedestrian avoided the environment. Participants felt that unkempt greenery contributed to the feeling of entrapment, which in turn was a reason for avoiding the environment. Both the presence of others and prospect were said to reduce the feeling of entrapment and increase the perception of safety, due to sufficient lighting and/or well-kept greenery. However, if participants perceived the environment as unsafe, then it led to avoidance. Avoidance may take many forms: some people avoid going out after dark, some may choose other modes of transportation to avoid walking in the neighbourhood, and others may choose alternative routes.

Most of the focus groups raised the topics of greenery (100%), lighting conditions (75%), and perceived safety (75%). This is noteworthy, since the interviewer did not mention these topics; they were not mentioned during the recruitment process, nor in relation to the overarching aim of the study. All participants lived in the neighbourhood where they walked, and had previously experienced the environment both during the day and after dark. The focus group discussions were held during the daytime, yet participants often referred to how they perceived the environment after dark.

The focus groups in all neighbourhoods discussed these topics, irrespective of urban planning strategy and the below-average crime rate (Rönneholm: greenery 51 times,

Fig. 6 Overview of the suggested relations between perceived safety, urban greenery, outdoor lighting, and the identified themes

lighting 24 times, and safety 36 times; Dammfri: greenery 98 times, lighting 44 times, and safety 56 times; Lorensborg: greenery 62 times, lighting 22 times, and safety 29 times). This shows that greenery, lighting conditions and perceived safety are important topics that influence the general impression of a neighbourhood.

Malmö has the smallest area of green space per capita of all Swedish cities (Statistics Sweden 2015), so the interplay between greenery and outdoor lighting may be assumed to play an even greater role for the perception of safety in cities with more green environments. The participants in Dammfri discussed the topics more frequently than the other participants. This might be because the path in Dammfri passed through a stretch of unkempt greenery and mesh fences, which may have triggered the discussions concerning the topics included in this study.

Even though the gender distribution among the participants was more or less equal, women expressed a greater proportion of the comments related to lighting (76%) and perceived safety (69%). The gender difference was less pronounced for greenery (58%). The overrepresentation of women in the discussions regarding lighting and perceived safety probably reflects their greater concern about these topics, which is in line with previous findings (Boomsma and Steg 2014; Paydar et al. 2017; Madge 1997). This highlights the importance of taking female pedestrians' needs into account, making cities available for all citizens, and paying special attention to the needs of vulnerable groups in line with UN's sustainability goals (United Nations 2017).

Conclusions and implications for research and practice

This study illustrates the complexity of how pedestrians perceive safety, and highlights the need for urban designers to consider the temporal aspect when planning sustainable pedestrian-friendly neighbourhoods, especially in northern latitudes where daylight hours are shorter in the winter-time and most people return home from work or school in the dark. Walkways, urban greenery and outdoor lighting must be considered in combination, since their interaction influences the pedestrian experience and impacts the walkability of the neighbourhood. Green environments are an essential element in sustainable urban design, due to the environmental benefits associated with urban greenery. However, unkempt urban greenery in areas with unsatisfactory street lighting conditions may limit pedestrians' route choices after dark and force them to make detours. To make cities accessible for all groups of people, all year around, pedestrians must either be provided with acceptable alternative routes, or green environments must be sufficiently lit and designed with safety in mind.

In this study, unsatisfactory greenery and lighting conditions impacted the walking route choices of the participants, and at some locations constituted an obstacle to the most direct path. This is important because the overall attractiveness of walking for transportation might be reduced if pedestrians perceive part of a route as unpleasant or if detours make the trip less convenient (Johansson et al. 2016). In the effort to create an inclusive and socially sustainable society as envisioned in the UN Sustainable Development Goals (United Nations 2017), where the city is to be accessible for all groups of people, both day and night, municipalities need to address these weak spots to guarantee an acceptable baseline and to encourage people to walk for transportation. An increase of pedestrians may be a self-reinforcing factor that encourages others to walk, including after dark.

In the focus group discussions, women more frequently expressed concern about lighting conditions in relation to perceived safety. This may be understood if a gender perspective is applied in urban planning, assuming that underlying patriarchal structures implicitly influence the urban space and manifest as gender differences in accessibility and freedom of movement in the city (Beebejaun 2017; Fenster 2005). Urban planners can therefore contribute to a more inclusive society by taking greater consideration of women's experiences and needs.

Theoretical models on human–environment transaction are useful for deepening the understanding of the role of urban greenery and lit environment in relation to the impact of these physical environmental factors on perceived safety. The results align well with the theoretical constructs of the models, and the models complement each other. Through its more detailed approach to the perception of the physical environment, the adapted prospect-refuge theory (Fisher and Nasar 1992) contributes by specifying the importance of the overarching visual impressions of prospect and refuge of the environment. The social-psychological model of fear of crime (van der Wurff et al. 1989) addresses in more detail the social environment, and helps to specify how the perception of other people becomes important, while also incorporating temporal aspects. The temporal aspects are essential for explaining the transformation in how green environments are perceived when day turns into night, and for predicting the circumstances in which the environment will be perceived as unsafe.

Appleton (1975) developed the original prospect-refuge theory with regard to aesthetic preferences for certain landscape characteristics based on an evolutionary rationale. In line with Appleton's conceptualisation, the prospect-refuge theory may also be applied as a tool for environmental design, as in the case of Hildebrand's analysis (Hildebrand 1991) of Frank Lloyd Wright's architecture, where prospect

and refuge are suggested to be two of the factors underlying the environmental preference for, and positive emotions evoked by, the interiors of his buildings. In recent years, the prospect-refuge theory has been widely applied with regard to environmental preferences of building interiors and of landscapes, but less so with regard to the urban environment (Dosen and Ostwald 2016). One exception is Galindo and Hidalgo (2007), who found prospect to be positively related to aesthetic preferences in the urban setting during the daytime.

In an attempt to quantify the prospect-refuge theory, Dawes and Ostwald (2013, 2014) applied isovist fields, a computational and mathematical analysis of the spatio-visual properties of paths in buildings. This approach has also been applied in outdoor settings (Batty 2001; Chih-Hung et al. 2016) and could be used to cast light on how the physical setting relates to perceived urban design qualities and to the aesthetic quality of an urban environment. Spatio-visual analysis could potentially be a tool for analysing problematic stretches of pedestrian paths, to promote more pedestrian-friendly urban design solutions.

The non-explicit approach taken in this study has the advantage of minimising the risk of response bias and unintentionally guiding the discussions. However, a more direct approach could be useful for further exploring the influence of greenery and lighting on perceived safety and on pedestrians' route choices. Overall, there is a need to advance understanding of the role played by the micro-level factors of the built environment in walking choices, so that obstacles can be identified, and measures taken to improve walkability.

Both technical and human aspects of lighting must be considered in attempts to create pedestrian-friendly environments. It is also important to consider users with special needs (such as the elderly and the visually impaired) while minimising energy use. National and international standards include measures for the assessment of technical aspects of outdoor lighting (Swedish Transport Administration 2015; CIE 2010) but, to date, there is no agreement on how to assess the pedestrians' response. A broad set of measures assessing the perceptions, subjective evaluations and behaviours of pedestrians should be developed, in order to systematically evaluate the perception of the lit environment and the interplay between urban greenery and outdoor lighting. This calls for empirical studies, both under controlled conditions and in the field.

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