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Windows: a study of residents' perceptions and uses in Sweden

RESEARCH

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ABSTRACT

What are inhabitants' perceptions and uses of windows in multi-dwelling buildings? This paper reports on a field study that explores daylight, the visual connection to the outside and the role of windows in the home during the day and night. Qualitative interviews were held with 20 participants living in multi-dwelling buildings. The thematic analysis identified two main components as characteristic of residents' experiences with their windows. The first, 'perceived dwelling comfort', consists of different types of comfort qualities, for example, keeping the body sufficiently warm or cool, blocking exterior noise, enabling visual tasks, perceiving the room to be adequately daylit, visually pleasant and spacious, obtaining visual privacy, and having an outside view to provide information and engagement. The second, 'preferred exposure to external elements' (*e.g.* air, sound, light, people outside) expresses a desire for personal control and reflects variability over time (momentary, daily, seasonal, ageing) and between individuals or groups. Windows represent an enjoyment of the home and fulfil much more than physical needs. They must allow sufficient personal control over fresh and cool air, sound, sunlight, streetlighting and privacy.

PRACTICE RELEVANCE

An enabling home environment affords residents opportunities to regulate the visual openness to the outside in order to satisfy individual needs for privacy or social connection. Preferences vary within and between household members, so window treatments must be easy for inhabitants to adjust. Housing designers and developers are advised to include exterior shading devices in the design and optional indoor window treatment to facilitate durable shading and privacy solutions. Further adjustments could be offered by landlords to tenants when they move in. Fenestration and shading devices offer the possibility to make full use of the available daylight, reduce electricity demand for indoor lighting and provide inhabitants with increased control of their comfort.

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1. INTRODUCTION

A growing body of field research has recognised the importance of windows for occupants in workplaces and schools (Lowden 2019). However, only a few field studies have taken an experience-centred approach, focusing on users' multiple needs and wants, when investigating residential windows (Bille 2013, 2017; Bournas *et al.* 2020; Hauge 2013, 2015; Logadóttir *et al.* 2013), residential indoor environmental qualities (Brunsgaard *et al.* 2012; Frontczak *et al.* 2012), residential wellbeing and comfort (Ellsworth-Krebs *et al.* 2019; Heijs & Stringer 1988; Madsen & Gram-Hanssen 2017; Wågø *et al.* 2016), and cultural differences in behaviour relating to comfort (Wilhite *et al.* 1996). Field research on sleep behaviour and preferences relating to windows is limited (*e.g.* Bjorvatn *et al.* 2017; National Sleep Foundation 2013), but a desire for a lower temperature in the bedroom has been reported in post-occupancy evaluations, for example, in bedrooms with mechanical ventilation (Berge & Mathisen 2016) or natural ventilation (Heide *et al.* 2021). Reports in the research literature on sleep experiences are even more scarce (Ellis 2017). What is particularly lacking is the temporal dimension and a holistic approach to residents' experiences with their windows during both day and night.

Scandinavia provides a challenging setting from a geographical perspective: shorter daylight hours in winter with the opposite situation in summer, the low-angle sun because of the high latitude, seasonal variation in vegetation and temperature, and the cloudy climate.

Another challenge is the demographic situation and urban densification (Godoy-Shimizu *et al.* 2021; Rinkinen *et al.* 2021). In Sweden, 63% of the population lives in large urban areas (Statistics Sweden 2020). Densification in cities has critical impacts on the design of new housing as well as existing dwellings in residential redevelopment areas. High urban density and certain architectural features, such as deep balconies or exterior circulation spaces of multi-dwelling buildings, have been shown to reduce the amount of daylight entering windows in existing residential areas (Bournas & Dubois 2019). The proximity of nearby buildings, that is, the obstruction to light or view, affects perceived comfort (Tregenza & Wilson 2011). Several tools are available to planners and architects for predicting satisfactory daylight conditions (Lewis 2017), but planning and building requirements, and on what to base them, are still debated (Tregenza & Mardaljevic 2016).

Historically, field research on windows has been conducted in factories, offices and schools (Boyce *et al.* 2003; Collins 1975; Küller & Lindsten 1992; Sundstrom & Sundstrom 1986). Little field research has focused on the physiological and psychological effects of residential windows (Veitch & Galasiu 2012), which is surprising as people spend, on average, 65% of their time indoors in homes (Brasche & Bischof 2005). Findings from workplaces are not necessarily applicable in a different context. The home represents a set of circumstances very different from those of the workplace because of the diverse groups of people living in homes, for example, children, older adults or people with ill-health. A variety of activities takes place in the home, often in the same room.

It is a common assumption that residents want daylight and to see a view (Collins 1975; Veitch & Galasiu 2012), yet closed blinds and curtains are common in residential areas during daylight hours (Petersen 2015). This paradox was another reason for the present study. Only a few studies have explored the significance of contemporary window dressing and use (curtain selection, when to open and draw them, and windowsill displays), for example, in interviews with older residents in London, UK (Ebbensgaard 2017), older residents and immigrants in The Hague, the Netherlands (Van der Horst & Messing 2006), locals and immigrants in Skien, Norway (Garvey 2005), and with residents in Copenhagen, Denmark (Bille 2019), and Utrecht, the Netherlands (Vera 1989). Findings show that front windows may express a fear of crime (preventing burglaries by protecting valuables from being in sight of potential thieves), identity (individual uniqueness and/or sameness), inclusion of the public while maintaining a domestic boundary, or privacy needs.

This paper reports on a study conducted as part of a larger project aiming to describe the characteristics and use of home lighting in Swedish homes. The study of indoor lighting from

electric light sources has been reported elsewhere (Gerhardsson *et al*., 2019, 2020). The present study focuses on windows, serving as sources of daylight. It addresses the following question:

> How do residents perceive their daylight and the role of windows in the home, during the day and night?

Throughout this study, the term 'windows' is used to refer to the entire package: the opening in the wall fitted with glass in a frame, the dressing (*i.e.* curtains, blinds, *etc.*), the window niche, and the view out for people on the inside and the view from the outside to the interior.

The concept of 'basic needs' served as a sensitising concept during data collection and characterised the interviews (Rennstam & Wästerfors 2018). The concept of basic psychological needs is essential in Basic Needs Theory, formulated by Deci & Ryan (2000, 2004). According to the theory, the social environment either supports or inhibits the active human nature. When social environments allow satisfaction of basic psychological needs, they will support healthy functioning, that is, growth and development of the individual and psychological wellbeing. Basic innate psychological needs are 'competence', 'autonomy' and 'relatedness'. *Competence* refers to an individual's very strong desire to have an effect on and gain control of the environment. *Autonomy* refers to being the perceived origin of one's behaviour, that is, experiencing their behaviour as an expression of the self. *Relatedness* reflects feeling connected to, caring for and being accepted by others. Innate psychological needs can be expressed in different ways depending on cultural contexts. Many theories explain the relationship between achieving valued goals and wellbeing. What distinguishes Basic Needs Theory, according to Deci and Ryan, is that it distinguishes goal contents and suggests a positive relationship between goal fulfilment and wellbeing only for goals that satisfy basic psychological needs.

The fulfilment of basic needs was thereby the broad idea guiding the enquiry concerning residents' daily experiences and interactions with their environment: in this case, their windows. Windows in an urban setting usually provide a view of neighbours in the housing estate's shared outside spaces, people in the street or residents in adjacent buildings. It is plausible that seeing or hearing others immediately outside one's home might partly satisfy a need for social connection—a sense of being part of a neighbourhood, community or a city. Personal control (Hellwig 2015), which reflects autonomy, has been shown to increase occupant satisfaction in other life domains, for example, with the luminous environment and control systems in daylit offices (Galasiu & Veitch 2006), thermal conditions (Luo *et al.* 2016) or general indoor environmental conditions in work settings (Day *et al.* 2020; Frontczak & Wargocki 2011). Residents also appreciate the adaptability and personal control of their indoor environment, for example, opening windows and switching off heating systems (Galassi & Madlener 2018; Hansen *et al.* 2018; Pedersen *et al.* 2021).

2. METHOD

The explorative approach and selected methods were motivated by the lack of research on the enquiry's subject matter: residents' perceptions of and interactions with their windows. Qualitative field interviews in people's private homes, photo-elicitation and observer-based environmental assessments (OBEA) were used to examine the role of windows in homes: their contribution to lighting and residents' dwelling experiences, during both day and night (***Figure 1***). The main motivation for adding participant photography to the research design was an expectation that this would elicit more information from the research interview, as it can encourage participants to talk and reflect (Harper 2002). Photographs can be especially effective when they involve something that is visual, such as objects or people, compared with less concrete day-to-day phenomena (Rose 2007). Structured interviews with open-ended questions were chosen to ensure that questions central to the topic would be the same across all interviews. Face-to-face interviews were held in residents' homes to enable observations of participants' home settings. The purpose of the interviews was not to make statistical generalisations, but analytical ones (Kvale & Brinkmann 2009).

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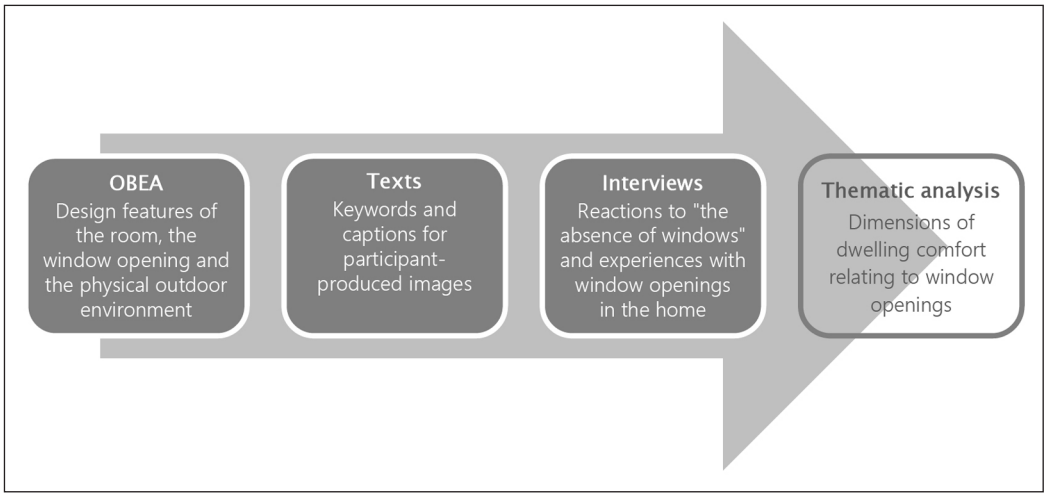

Figure 1: The thematic analysis is based on the following data: (1) design features, (2) keywords assigned by the participants to their photographs of the windows and (3) participants' accounts.

2.1 PARTICIPANTS

A convenience sample (n = 20) was recruited consisting of 10 female and 10 male residents, aged 24–93 years, with a variety of household size, housing tenure type, dwelling size and daylight conditions in the home (see Tables S1 and S2 and Figure S1 in the supplemental data online). Inclusion criteria were speakers of fluent Swedish, and adult residents living in apartments located in Metropolitan Malmö in southern Sweden. The sample was intentionally diversified in terms of age, gender and household size to obtain a wide range of experiences. The choice to include only residents living in multi-dwelling buildings ensured a relatively homogeneous sample and a smaller number of participants, since they were analysed as a single group. The sample was also homogeneous in terms of ethnicity, because the aim was not to compare differences between ethno-cultural groups. People in the researcher's network were approached and asked to invite contacts in their networks to participate in the study (close friends of the researcher were excluded). This sampling technique was preferred because people can otherwise be reluctant to agree to interviews in their private homes. As an incentive, the participants received either three lottery tickets or a movie voucher on completion.

2.2 MATERIALS

Information and type of material obtained were digital recordings of interviews, participant-produced images of their windows and room interiors, floor plans, and OBEA forms completed *in situ* by the researcher (***Figure 1***). Research material also included keywords or short descriptions added to the images by the participants. The purpose of the initial walk-through and the environmental assessment was to check that the participant had taken photographs of each window and not accidently missed any, to see the windows in the actual setting, to record interior features relevant to the research question, and to form an impression of the home before carrying out the interview. For example, measurements were taken of window size and room floor area for later calculation of the glazing-to-floor ratio as an indication of daylight availability in each room (see Table S2 in supplemental data online). The OBEA forms were further refined into The Window Treatment Inventory to be used in future on-site assessments (see Figure S2 in supplemental data online).

2.3 PROCEDURE AND ANALYSIS

Data were produced between March and May 2017. Initially, an invitation email was sent to participants explaining the purpose of the study and providing information about the requirements: a copy of the floor plan, if available, and a series of participant-produced photographs of the windows and the room interiors that were to be taken before the home visit. Participants who accepted the invitation to participate received detailed instructions by email and had 20 days to complete the assignment (see Figure S3 in the supplemental data online). They were given a total limit of 25 images and file size (approximately 1 MB), but distance range and time of day for the

photography were unrestricted. Participants were also asked to assign one to three keywords to each image of the windows in the hope of encouraging them to further reflect on the topic. The instruction was:

> Include between one and three characteristic keywords that capture something in the picture with the window opening, or something you thought about when taking the picture or looking at it afterwards. [...] If you find it difficult to come up with any keywords, you could imagine the opening has been blocked up so there is no window. What would a wall instead of a window opening mean to your everyday living, day and night?

The Swedish equivalent of the 'window opening' (or window aperture) was used in the written instructions rather than 'window' to encourage the participants to focus not only on the window as a material object or purely a visual unit.

Before the interviews, the images, including the keywords, were assembled by the researcher as an album. Examples of participant-produced images and keywords are shown in Figures S4 and S5 in the supplemental data online. Each pair consists of a view from the inside looking at the window and a view of the room taken from the window. The participant only assigned keywords to images of the windows.

Home visits began with a walkthrough with the participant, who assisted in taking some of the measurements, such as the height of the windowsill above the floor. During the walkthrough, observations of interior features relevant to the lighting situation were continuously recorded on a prepared form and on the floor plan. Features observed were:

- the placement of air intakes
- inward- or outward-opening windows
- external shading devices
- fabric of interior shading
- surface colours of flooring and walls (light, medium or dark)
- colour of window frames, mullions and glazing bars (light, dark)
- electric lighting turned on and/or shaded windows during daytime
- type of room-darkening device
- splay angle of window reveals
- window recess measurement
- size of the window aperture (for later calculation of the window-to-external wall ratio)
- glazing size and room floor area (for later calculation of the glazing-to-floor ratio).

The interview was structured with open-ended questions (see the interview guide in supplemental online data) and the photo album was used to facilitate discussion. Participants were asked to consider one photograph at a time and to respond to the following question:

> Imagine the window opening has been blocked up and there is no window anymore. How would it affect your use of the room and your dwelling—during the day and night?

Asking directly about what actions windows enable and how they influence residents' dwelling experience may not be an easy task in an interview situation, because windows can be taken for granted and something on which participants may not previously have reflected. If not addressed by the participant during the interview, additional follow-up questions were asked regarding, for example, satisfaction with and use of daylight, the possibilities to make the bedroom darker at night, and the preferences of other household members.

The recorded interviews varied in length (30–75 minutes), depending on the number of windows and on how much participants elaborated their answers to the researcher's questions. The total duration of the home visit, including the walk-through and the interview, was between one and two hours. Field-notes were recorded by the researcher after the visit, including participant characteristics and reflections.

When all material had been collected, the researcher carried out a thematic analysis of the interviews. The participant-produced images were not analysed, since the purpose of the photographs in this case was to encourage participants to talk about and reflect on their experiences with their windows. The thematic analysis followed a multiple-stage process as proposed by Braun & Clarke (2006), including moving back and forth between steps. Codes were developed after data collection and included a first- and second-cycle coding (Miles *et al*. 2014); in other words, sorting interview excerpts and categorising them according to researcher-produced labels (Kvale & Brinkmann 2009).

First, interviews were summarised and selected comments, relevant to the research question, were transcribed. In parallel, ideas for a content-based coding were written down, such as 'dwelling comfort', 'preference for daylight', 'lighting control and shading devices' and 'design features'. Second, comments and responses to interview questions were coded more holistically (Miles *et al*. 2014), using 'dwelling comfort' as a general theme identified when transcribing. Rather than line-by-line coding, this coding method entails applying a single code to a large unit of the text to obtain a sense of the overall contents and potential categories. The general theme was later divided into three main themes: 'physical dimension', 'psychological/aesthetic dimension' and 'social dimension' of dwelling comfort. Third, when the transcripts were re-read, data extracts coded as one of the themes were sub-coded (comfort qualities). Sub-themes belonging to the 'physical dimension' included indoor air quality and thermal comfort, acoustic comfort, and visual comfort. Sub-themes grouped as 'psychological/aesthetic dimension' included spatial brightness, indoor pleasantness and improvement in mood. Sub-themes associated with the 'social dimension' included visual cues for people outside (*e.g.* statements concerning reluctance to close the venetian blinds).

However, such a distinction in three dimensions was found to be too strict, because it did not allow for overlapping elements. While the sub-themes (labelled as comfort qualities) remained unchanged in the final analytical framework, the titles of the main themes and descriptors were revised and refined during the coding process, resulting in two final main themes: 'perceived dwelling comfort' and 'preferred exposure to external elements'. The first main theme, 'perceived dwelling comfort', is visualised as a spectrum, along which each sub-theme is placed depending on the orientation towards either the external or the internal environment.

An additional sorting across the sub-themes (*i.e.* the types of comfort qualities) comprised four elements: 'air and sound', 'illumination', 'looking in through the window' and 'view out'. These elements correspond to the four major groups that were identified when sorting and coding participants' keywords (***Figure 2***). Additional keyword categories were 'activities' and 'mental wellbeing'.

3. RESULTS

Keywords assigned by the participants to their images (see Figures S4 and S5 in the supplemental data online) can be divided into four major groups (***Figure 2***). The most frequently mentioned words relate to 'illumination', for example, light, shadows, sun, dark. Equally common were keywords relating to a 'view out', for example, movement, nature, people, seasons, neighbours, city. The third main group concerns 'air and sound', for example, keywords were air exchange, traffic noise, practical, heat, calm. The final group reflected 'looking in through the window', for example, shielded, observing.

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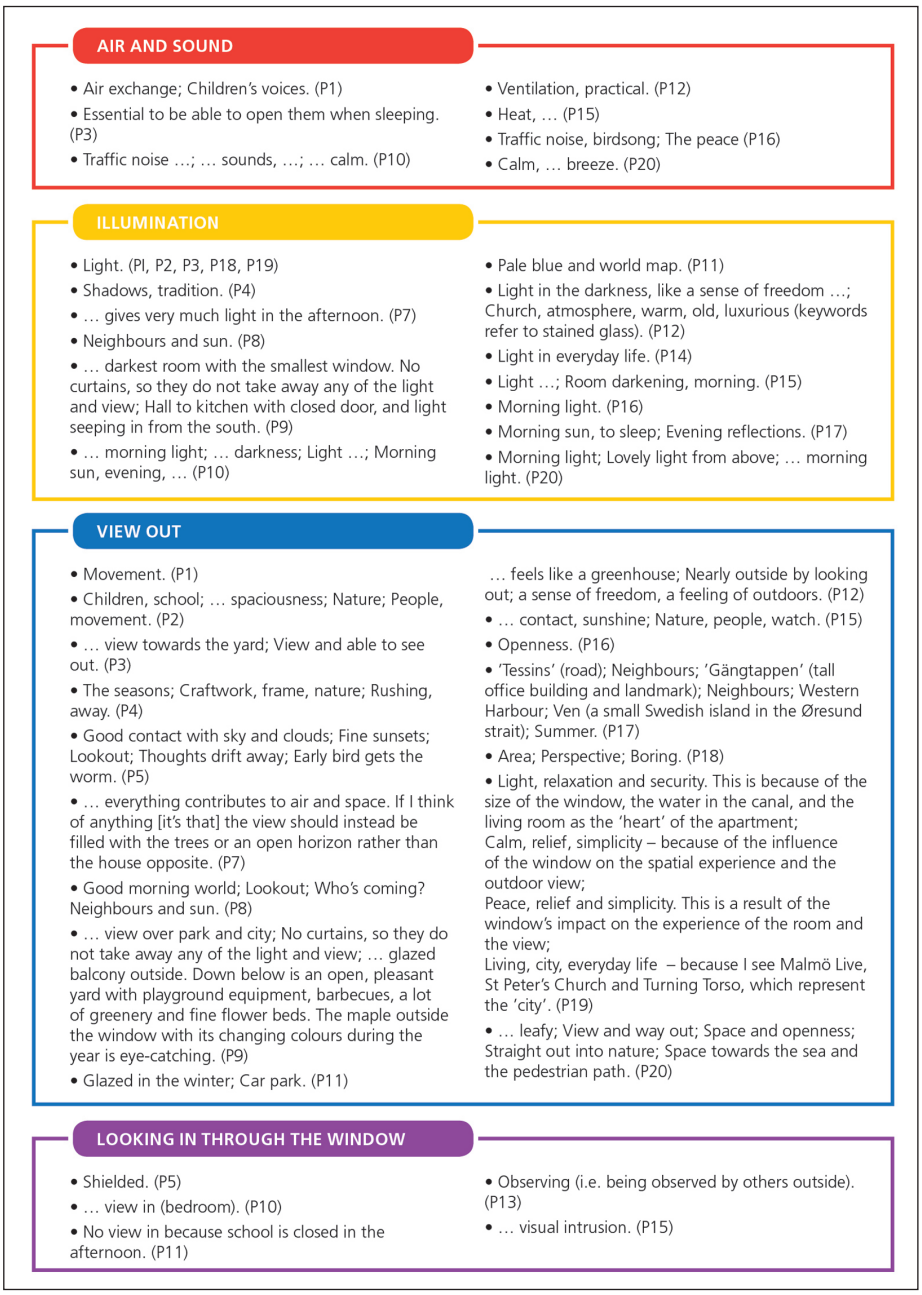

Figure 2: Keywords assigned by the participants to their images divided into four major groups.

The thematic analysis of participant interviews identified two main themes or components as characteristic of how participants experienced their windows during the day and night: 'perceived dwelling comfort' and 'preferred exposure to external elements'.

The first component, 'perceived dwelling comfort', is visualised as a continuum and consists of 16 comfort qualities oriented either more towards the internal environment or more to the external (***Figure 3***). Comfort qualities on the left-hand side of the continuum are not dependent on a view out through the window, and concern the internal environment, for example, the provision of fresh or cool air, darkness to improve sleep, and daylight illumination for managing visual tasks, creating a visually pleasant indoor environment and improving mood. These comfort qualities roughly correspond to what a person may experience when turned away from the window facing the room, as opposed to looking out through the window facing the external environment. For example, a window admitting daylight into the room impacts on bodily sensations, room appearance to the viewer and its use, regardless of whether the window is in the field of view. Another example is at night when the outside air from an open window will cool the body in bed. However, there is a double movement of air, sound and light inwards and outwards captured by the graphical representation, influencing both residents inside and people outside.

Comfort qualities on the right-hand side of the continuum side are oriented more towards the environment outside: visual openness to a view, sensory information about seasonal changes, weather and other physical conditions, observation of, verbal communication with, and visual information for people outside.

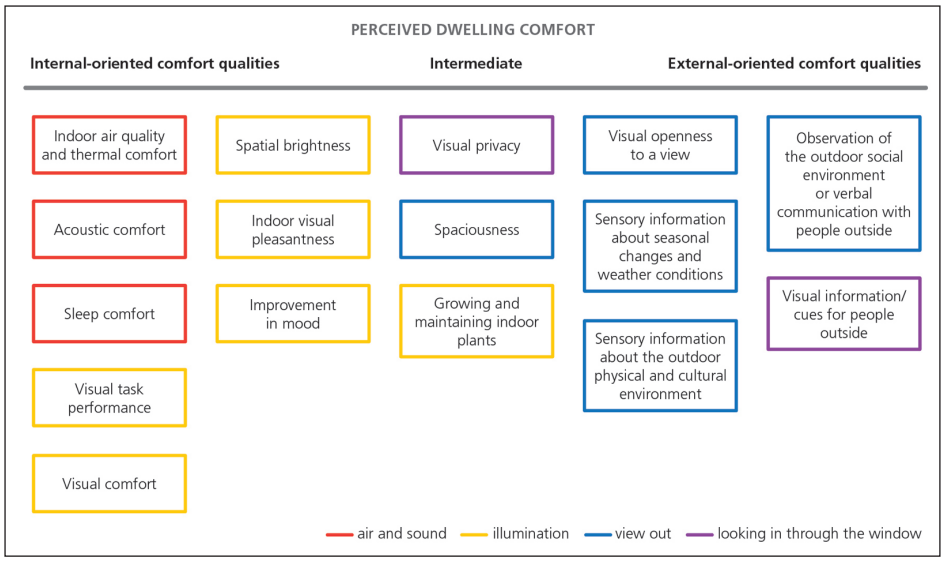

Figure 3: Perceived dwelling comfort: an analytical framework of residents' views on the role of windows in the home.

Note: Colour coding represents horizontal themes corresponding to the major groups of participants' keywords.

Between the extremes are comfort qualities relating to both the internal and external environment: visual privacy, spaciousness and growing indoor plants on the windowsill. The latter can be for enjoyment, to obtain visual privacy or because the home looks more inhabited for people outside.

The second component, 'preferred exposure to external elements', draws attention to how important choice and preference are to the inhabitants who want more or less exposure to external elements. It concerns whether windows and their treatments allow for more or less exposure to both natural elements (*e.g.* air and sound, daylight and heat) and other environmental elements outside (*e.g.* greenery, sky, street lights, residents in opposite homes, or the gaze of people passing outside). It expresses a desire for personal adjustments and captures how behaviour and preferences vary within individuals over time (daily, seasonal, ageing) and between individuals or groups depending on cultural norms.

3.1 PERCEIVED DWELLING COMFORT

Based on participants' keywords and accounts, the window can be regarded as a provider of practical utilities, for example, fresh air or plenty of daylight to manage certain visual tasks, representing the left end of the dwelling comfort continuum. Such utilities relate to visual, auditory and tactile perceptions—those factors commonly referred to as comfort in the research literature on post-occupancy evaluations (visual, acoustic comfort and thermal comfort). However, time must also be included: the provision of an enabling environment that helps residents maintain a daily rhythm and sleep comfort.

The practical use of daylight for illumination, and concern for comfort in general, was expressed in all interviews. For example, one participant (P16), aged 34, responded to the hypothetical windowless situation in the kitchen by stating that it would make the room much less usable:

> Because you wouldn't feel so comfortable in there, quite simply. In addition to being practical—it's difficult to have a lamp that gives as much light as a window.

Responses to the main question about the absence of windows also indicate a strong appreciation for daylight enabling other visual experiences than visual task performance and a view. Reasons are psychological (*e.g.* improved mood) and aesthetic (*e.g.* spatial brightness, indoor visual pleasantness and perceived spaciousness).

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One participant (P15), aged 36, lived with her six-year-old child. When they moved, she chose a ground-floor apartment partly protected from the midday sun by a projecting balcony. She felt they would probably not spend that much time in the kitchen if there were no windows. To encourage her to elaborate on reasons and consequences, she was asked whether she had any experience of staying in a windowless hotel room. After a moment of reflection, she concluded that the kitchen would not be bright enough with electric lighting. Also, she felt natural light filled the entire area, whereas electric light 'gives more of a cosy light'. She described various qualities of daylight, such as light distribution and increased room brightness, but also the importance of looking out through the window, and that it influenced her choice of seating. More specifically, she appreciated the visual openness to a view with certain view qualities, such as birds, the sky and playmates. To her, information on weather conditions was also essential. Another comment, by the same participant, involved the observation of her son's playmates approaching and, implicitly, the anticipation of interactions with her son. Such view qualities reflect externally oriented comfort qualities.

However, participants also expressed the need to screen windows to prevent visual intrusion. Participant P13, aged 26, lived in a one-bedroom apartment on the ground floor facing the courtyard. Sometimes people coming from the bus stop would pass outside, taking a shortcut through the housing estate. He was not used to people looking in through the window as he previously lived on the fourth floor. The venetian blinds were down with closed slats in the glazed terrace door. Curtains were drawn in the adjacent window. His response to the question about the absence of windows in the room was that it would have prevented people looking in, but he would have felt very shut-in. He would have liked a more permanent solution to ensure his privacy, but still enjoyed the benefits of daylight, so he planned to apply a self-adhesive frosted film to the lower part of the windows and the terrace door:

> I don't want to see their faces when I'm sitting down, but when I'm standing and see their faces, I can wave to them.

Therefore, visual privacy is not necessary for all situations—it may vary depending on what activity the resident is involved in, or whether they are seated or standing.

At the right end of the dwelling comfort continuum are externally oriented comfort qualities that allow the interaction between residents and people outside, mediated by the window: observation or verbal communication, and visual information/cues for people outside. The following are examples from the interviews illustrating each comfort quality.

To one participant (P18), aged 24, it was critical to be able to identify unexpected outdoor sounds. He lived with his partner in a three-bedroom apartment on the second floor. Standing close to the window in the guest room, he could overlook the car park and the entrance to the housing estate (***Figure 4***). The view was partly obstructed by a windowless gable wall of the adjacent residential building 18 m away. The windowsill was 85 cm above the floor. He described himself as an anxious person when he gave the following response to the question about a windowless situation in the guestroom:

Figure 4: The window in the guest room in the apartment of participant P18.

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> From here, it would be like being in a prison if you just had the [right] window. [...] It's quite nice to have these windows and be able to look out towards the car park and see who's coming from there—in the event of hearing some noise outside.

Participants' window arrangements, such as shading solutions, lamps or other objects on the windowsill, act as visual cues for people outside, such as in the following example. Participant P1, aged 77, lived with her husband in a three-bedroom apartment on the third floor. They slept in separate bedrooms, partly because her husband was more of an evening person, while she was a morning person. There were no buildings obstructing the view. She had chosen to fit her windows in the living room with vertical strip blinds of light-coloured fabric. Windows were also fitted with horizontal venetian blinds, but she preferred the former because they did not imply social withdrawal:

> With [venetian] blinds, you're saying, we don't want to see anyone, we don't want to talk with anyone, we just want to shut ourselves in. So, you perhaps feel you're shutting yourself in.

Drawing the curtains may also be done out of privacy concerns for neighbours in opposite buildings. Participant P5, aged 93, lived in a three-bedroom apartment on the third floor. He drew the curtains slightly when he rode his stationary exercise bike in the library/television room. He did not want the neighbours living opposite to think he was looking into their apartments. A related comment was expressed by another participant (P6), aged 62, who lived in a two-bedroom apartment facing the yard and the street. Across the street, 18 m from her window, stands a four-storey building. She was asked whether anything about the street view bothered her, upon which she commented that residents across the street often had open curtains. Living in dense urban areas includes silent agreements about appropriate behaviours, such as not staring through someone else's window. She concluded:

> everyone respects window etiquette or housing etiquette in the centre of the city. You see here that the others have it quite open.

The information embedded in window arrangements is also mentioned by participant P13, aged 26, who lived in a one-bedroom apartment on the ground floor facing the courtyard. His windows were fitted with both curtains for darkening and venetian blinds, but he preferred to use the curtains for privacy, and explained why:

> For others who walk past, it feels strange. It feels suspicious that the blinds are pulled down all the time. If you don't pull them up or down—if they're always down—it feels like, 'what's going on in there?'

Other reasons for having closed curtains, or venetian blinds, might be because the room was not in use and because neighbours showed similar behaviour. For example, participant P15, aged 36, keeps her blinds in her east-facing bedroom completely closed because the bedroom overlooked the common pathway where neighbours passed. She mentioned that most people had closed curtains in her block, which fronts onto the pathway. In the morning, the wake-up light, rather than the morning sun, illuminated her bedroom.

Some participants mentioned that the window must have a pleasant display. Participant P6, aged 62, who lived in the central part of the city, expressed it as:

> a kind of obligation to arrange one's window niches because they can be seen by people passing by.

Another participant (P8), aged 70, living in a three-bedroom apartment on the ground floor, favoured table lamps and flowerpots in the window, 'because it's nice to have them—and it looks a bit more inhabited'. Illuminated windows were also appreciated by participant P9, aged 83, living on the second floor in a peripheral part of the city with no buildings blocking the view onto the neighbourhood centre (***Figure 5***):

Figure 5: The window in the kitchen in the apartment of participant P9.

> It's like a screen of indoor residential lighting and street lighting that gives a feel of living in a city. I think that's nice.

This section has provided a selection of descriptions of 'perceived dwelling comfort', ranging from internal to externally oriented comfort qualities. A more comprehensive overview with examples from participant interviews illustrating each comfort quality is given in ***Tables 1–3***. The essential characteristics of all 16 comfort qualities were identified within the first nine transcripts. After the ninth transcript, no new comfort qualities relating to windows were identified.

Table 1: Thematic analysis: internally oriented comfort qualities relating to windows.

Note: [a] Numbers represent the prevalence of the themes across the participants. For example, '20' signifies that all 20 participants referred to the particular theme.

COMFORT QUALITY[a]	DESCRIPTION	EMPIRICAL EXAMPLES
Indoor air quality and thermal comfort (20)	Characterised by fresh air, cooling and heating, and involves natural ventilation, passive cooling and solar heat gain	Opening the windows for ventilation; to improve ventilation because air inlets are not sufficient in summer; or to lower the indoor temperature; wanting exterior shades or having them installed or an appreciation of a projecting balcony above the window (in modern low-energy buildings)
Acoustic comfort (9)	Characterised by the avoidance of disturbing or undesired outdoor sounds	Undesired sounds, such as seagulls being noisy early in the morning, traffic, and waste collection trucks
Sleep comfort (20)	Characterised by the daily rhythm through light/dark exposure; the avoidance of disturbing light (or too much darkness) and noise during sleep; and maintaining a cooler temperature during the night	Problems with darkening the room during the day after a night shift; wearing a sleep mask; waking up with daylight or sunlight; having the bedroom window open to reduce the temperature; the feel of cool air (*e.g.* when the duvet is removed); the feel of fresh air; preferring the bedroom to be even darker than you can make it; preferring some light seeping through sheer curtains or half-closed venetian blinds because you dislike darkness and are scared of the dark; letting in daylight during the daytime and wanting it to be dark in the evening
Visual task performance (11)	Characterised by daylight illumination in terms of adequate lighting to make the completion of a task easier	Daytime cleaning with daylight; reduced daylight on the task area because of dark bookshelves, and the location of the desk; poor daylighting conditions during the day when playing; adequate daylight in the kitchen for some tasks, for example, making a sandwich, but inadequate for other tasks, for example, cooking dinner and reading a recipe; needing more light in later age

(Contd.)

COMFORT QUALITY[a]	DESCRIPTION	EMPIRICAL EXAMPLES
Visual comfort (13)	Characterised by daylight illumination that minimises uncomfortable visual contrast, glare and reflected glare	Reflected glare from bright external surfaces, for example, a newly installed copper roof, white exterior walls of adjacent buildings; reflected glare from the television screen making it difficult to see
Spatial brightness (20)	Characterised by daylight illumination and enabling an adequately daylit room (ambient lighting)	The whole room has to be bright; plenty of light; contrasts; colour nuances affected by the weather; variation that makes daylight more vivid and less sterile
Indoor visual pleasantness (11)	Characterised by daylight illumination and enabling the visual appearance of the window, objects, people and interior surfaces of the room	Avoiding direct sunlight to preserve the flooring, a nice tablecloth on the kitchen table or a tapestry on the wall; unshielded windows because mullions and glazing bars are carefully moulded
Improvement in mood (4)	Characterised by daylight illumination	Feeling good from the light you receive every day; feeling bad when it is dark; feeling almost depressed with a view of just a brick wall; 'light makes me so alert'
Visual privacy (15)	Characterised by a view into the dwelling which is perceived as intrusive (and concerns about how to screen from the gaze of people passing outside)	People outside watching activities inside; translucent glass for privacy; attaching tinted film on a balcony glass railing or door glass; people outside seeing the programme on the television
Spaciousness (15)	Characterised by a view out, and suggesting visual openness or enclosure produced by an interior. It has less to do with illumination because the feeling of enclosure can be experienced at night without much light from the outside. View distance may affect the perception of spaciousness more than illumination through the window. Imagine, for example, translucent glazing, a light-coloured tent fabric with no transparent 'windows', or thick fog	Feeling confined when there are no windows, or like living in a prison cell; feeling that the apartment is a bit bigger; a view to a brick wall generates a feeling of confinement; closeness to adjacent buildings decreases the feeling of space and light; appreciation of living high above ground level where light filters in from all directions; feeling of freedom with a panoramic window; a feeling of the outside indoors
Growing and maintaining indoor plants (5)	Characterised by daylight illumination (and by a view in)	Growing pot plants because it looks more inhabited or for aesthetic reasons (less sterile when not having curtains), or to reduce visual intrusion; starting seeds

Table 2: Thematic analysis: intermediate comfort qualities (either internal or externally oriented, or both) relating to windows.

Note: [a] Numbers represent the prevalence of the themes across the participants. For example, '20' signifies that all 20 participants referred to the particular theme.

3.2 PREFERRED EXPOSURE TO EXTERNAL ELEMENTS

The second component, 'preferred exposure to external elements', to a greater or lesser extent is dependent on the situation. It reflects a diversity of preferences of participants regarding the treatment and control of windows. For example, the interviews revealed several reasons for having closed blinds or curtains, for example, to keep the room cool (physical), temporarily closed when dressing (psychological), and to prevent the colour change of the wooden floor changing (aesthetic). Another reason is given by participant P11, aged 56, who appreciates daylight because of its variability, but who does not raise the bedroom blinds during the day. As she spent only a little time in the bedroom during the daytime, she did not 'bother to pull them up'.

Additional reasons are personal characteristics, one of which was illustrated by participant P18. He appreciated that his windows enabled him to watch the outdoor social environment. His partner,

COMFORT QUALITY[a]	DESCRIPTION	EMPIRICAL EXAMPLES
Visual openness to a view (17)	Characterised by a view out that has certain qualities regarding view content, view distance and view elements	Seeing nature outside; looking out through the window; trees moving in the wind; garden; clouds; the sun's path across the sky; birds; the park; the cityscape; people; too dense and close to adjacent houses
Sensory information about seasonal changes and weather conditions (14)	Characterised by a view out and enabling sensory information from the outside, such as sound, or to be able to open the window and feel the wind and outdoor temperature	Vegetation that indicates the time of year; the croaking of frogs and toads during summer nights; to be able to check the weather; rain falling on hard surfaces
Sensory information about the outdoor physical and cultural environment (9)	Characterised by a view out onto the physical environment, urban culture or cultural heritage, and enabling sensory information, such as hearing urban sounds	A historic castle in the area; connection to the outside (having a view out and hearing sounds); the voices of students passing in at night (as a sign of life in a city); hearing birds chirping or people talking outside; seeing and listening to the sounds of a busy city street with cars and buses
Observation of the outdoor social environment, or verbal communication with people outside (13)	Characterised by the view out and enabling sensory information, such as voices talking or dogs barking, and verbal communication	Checking whether a neighbour's car is in the car park to see if they are home; checking for intruders through the window; calling out to someone; watching her child playing football outside
Visual information/cues for people outside (9)	Characterised by a non-intrusive view in, and requires visual openness enabling inhabitants to provide visual cues for people outside	Choosing interior window treatments depending on how others perceive them, for example, roller blinds or curtains instead of venetian blinds; creating a pleasing window display for people outside with flowerpots and lamps on the windowsill; appreciation of seeing other residents' indoor lighting

Table 3: Thematic analysis: externally oriented comfort qualities relating to windows.

Note: [a] Numbers represent the prevalence of the themes across the participants. For example, '20' signifies that all 20 participants referred to the particular theme.

however, lowered and closed the blinds during daylight hours in the living room facing west, in both summer and winter, with either sunny or cloudy skies.

Individual sensitivity to visual comfort or daily rhythm characterises participant P9, aged 83. She lived in a two-bedroom apartment on the second floor. She preferred light-coloured roller blinds at night, which covered the windows, and interior glazing between rooms, and closed doors between rooms. Her stated reason was that there should be light during the daytime and dark in the evening (*i.e.* light from outside should be screened off).

Age-related visual impairment is another individual characteristic that affects how older residents interact with their windows, respond to the daylight situation or electric outdoor light entering the room at night, or appreciate windows. The previous participant P9 was asked about her current vision since she had a cataract operation some four years ago. Her response to the question about how she perceived the brightness in her apartment after the operation was that the electric lights, which previously had appeared as a 'veiled light', became more of a 'matter-of-fact light'. Participant P5, aged 93, who lived with his wife, suffered from macular degeneration. He appreciated the unobstructed view to the outside from the kitchen and living room that faced west, on the third floor (***Figure 6***). He was able to distinguish the clouds and the green foliage, but had become more sensitive to glare in recent years. They had a motor-driven window awning installed to shield the sunlight in the afternoon. Glare was also produced by the bright white walls of the opposite buildings visible from his bedroom.

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Figure 6: The window (left photo) and the balcony door (right photo) in the in the living room in the apartment of participant P5, with his corresponding captions: (a) 'Good contact with the sky and clouds' and (b) 'Exit'.

3.3 PERCEPTION OF DAYLIGHT

Participants' perceptions of their daylight were also included in the research question. Drawing on the findings in the previous sections, daylight is appreciated for many reasons. One practical reason is the need for daylight as a time indicator providing a daily rhythm, for example, making waking up and getting out of bed easier in the morning. The provision of daylight makes it easier to perform certain tasks, such as cleaning, performing deskwork or eating meals in the kitchen. Participants also prefer daylight to electric light because it varies, increases room brightness and improves mood.

Distinguishing between daylight and the view is not always obvious. Many participants mentioned room spaciousness as a valued quality, but whether it is mostly influenced by daylight or the view is not clear. The interpretation here is that perceived spaciousness is more connected with having a view of the outdoors, whether it be a wall or nature, because windows are appreciated even in the evening after daylight hours.

4. DISCUSSION

Inhabitants' perceptions of the role of windows in the home shows they acknowledge and expect windows to make a range of different contributions:

- to provide practical services, for example, cool air, task lighting and daily rhythm
- to support additional experiences of comfort, for example, spatial brightness, indoor pleasantness, improved mood, spaciousness and visual privacy
- to mediate information about outdoor conditions and interaction between residents and people outside—allowing observation, verbal communication and the use of intentional or unintentional visual cues.

Windows are valued for what they tell residents about the room they are in and what is going on outside, and for what windows tell people outside about what is happening inside.

Considering the context (urban dwellings at high latitudes) and the findings, two insights arise. First, the transparent feature of windows is essential. Second, windows could be regarded as cultural expressions of basic psychological needs.

The analytical framework characterises a range of comfort qualities along a continuum and gives equal weight to both ends of the continuum (the indoor and outdoor environments). Consequently, these comfort qualities demand transparent glass (in both directions) and openable windows (at

least one in each room). The findings suggest that in a Swedish context the signs of inhabitation in a window are something that residents appreciate.

It is well established in the academic literature on home comfort that physical comfort (air quality, thermal, acoustic and visual comfort) is of key importance to residents (Ellsworth-Krebs *et al.* 2019). Participants in this study often mentioned other types of comfort qualities, suggesting thematic importance. This is supported by quantitative survey findings on indoor environmental quality in Danish housing (Frontczak *et al.* 2012).

Externally oriented comfort qualities may involve either approach (observation) or avoidance (visual intrusion) of the outdoor environment to meet needs and desires. The conflict between the need for visual privacy and the desire for daylight has been shown in one study exploring the relationship between architectural features and user behaviour in student housing (Rokosni 2019). As a few previous studies have found, observation and non-verbal communication (*e.g.* closed curtains or blinds) have impacts beyond the dwelling and its inhabitants (Bille 2019; Ebbensgaard 2017; Garvey 2005; Van der Horst & Messing 2006; Vera 1989). A single window, illuminated by an electric lamp in the evening, may benefit many people outside in terms of perceived security (Ebbensgaard 2019). The finding is similar to what Bille (2013) identified as 'a sense of secureness and community'. Electric lights in the window for people outside after daylight hours was also observed in a previous study (Gerhardsson *et al*., 2020).

How residents interact with windows and what they expect from them might reflect two underlying 'basic psychological needs' (Deci & Ryan 2000): relatedness and autonomy. Windows, transparent in both directions, enable the environmental conditions (social connection) to support the basic need for *relatedness*. For example, by following 'window blind etiquette', people show they care for others or want to be accepted by others. *Autonomy* is represented by participants' own decisions on when to adjust daylight controls (blinds, curtains, external shades) to improve sleep, daylight or privacy. Even if others are indirectly involved in 'window blind etiquette', residents may endorse such values, and the chosen actions will still be an expression of the self. The need for autonomy is also expressed by individual screening in a multi-dwelling building, for example, attaching tinted film to a balcony glass railing to prevent visual intrusion without needing to obtain permission from the landlord or the tenant owners' association. Other studies have also linked dwelling comfort to the ability to manage the home as desired (*e.g.* Ellsworth-Krebs *et al.* 2019) and to control electric lighting systems manually in student accommodations (Rokosni 2019).

4.1 PRACTICAL IMPLICATIONS AND FUTURE WORK

This study found that inhabitants want an enabling home environment where they can regulate the visual openness to the outside to satisfy individual needs for privacy or social connection. Based on this, housing designers and developers are advised to include exterior shading devices in the design and optional indoor window treatment on construction to facilitate sustainable shading and privacy solutions. Tenants could be offered adjustments by the landlords when they move in, which would benefit both parties.

Implications also arise for planning and policies. Climate change adaptation in the built environment involves the prevention of increased indoor temperatures in homes during longer heatwaves, even at higher latitudes (Lundgren Kownacki *et al.* 2019). Passive measures, for example, through sunshades and openable windows, are preferred to avoid energy use for active cooling. The findings here show that openable windows equipped with shading devices also correspond to residents' needs and desires. A climate-sensitive site layout and building design, including fenestration, shading devices and natural ventilation, offer the possibility to reduce electricity use for indoor residential lighting, as well as reducing heating and cooling demands.

In Sweden, the National Board of Housing, Building and Planning's (n.d.) building regulations are currently under revision (Building Rules Modernisation Committee 2019). One of the proposed mandatory requirements is to ensure that areas for sleep and rest, social interaction and leisure, and meals have windows with a view to the outside from both standing and seated positions (windowless bathrooms and areas for meal preparation are deemed acceptable). The findings of

the present study provide support for such a requirement, as residents perceive an external view to be essential. Drawing on the findings, one could go even further and require a view to the outside of the sky and/or the ground. One consequence is that the height of the windowsill in apartments above the ground floor should allow a view over public paths and places. For the same reason, deep balconies along the entire window wall should be avoided for apartments that have only a single-aspect exposure.

Future quantitative research on dwelling comfort could include additional variables in occupancy evaluations. Such evaluations are often limited to the following four indoor environmental quality factors based on either technical or subjective measures (Ortiz *et al.* 2017; Wierzbicka *et al.* 2018): air quality, thermal (temperature), noise (acoustic) and daylight (visual comfort) (Brunsgaard *et al.* 2012; Frontczak & Wargocki 2011; Hansen *et al.* 2019). This paper proposes that an additional factor is added: 'sleep comfort'. Future survey research could base questionnaire items on the analytical framework of this paper (***Figure 3***), using the comfort qualities and possibilities for manually adjusting the exposure to external elements as predictors of dwelling comfort satisfaction. Research on outdoor lighting and perceived security in the public realm should consider indoor residential lighting that is visible through the windows.

5. CONCLUSIONS

This explorative study gained insights into inhabitants' experiences with their windows during both the day and night in a Swedish urban context involving multi-dwelling buildings. There is much more to such experiences than the satisfaction of physical needs (modulating indoor temperatures, blocking exterior noise or enabling visual tasks). Perceiving a room to be adequately daylit, pleasant and spacious seems to be equally essential, and a view of the world outside brings information to inhabitants. However, windows also need to screen the gaze of people outside from peering in, moderate bright sunlight during the day, illuminate 'black' windowpanes in the evening and mask streetlighting at night. Initial and running costs for residential windows and their treatment must include concerns about both dwelling comfort and possibilities for personal adjustments.

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AUTHOR CONTRIBUTIONS

K.M.G. designed the study, and T.L. contributed to the design. K.M.G. collected and interpreted all data and drafted the article. T.L. made critical revisions.

COMPETING INTERESTS

The authors have no competing interests to declare.

ETHICAL APPROVAL

According to national recommendations, no formal ethical approval is needed for studies that do not elicit data concerning sensitive information and do not include any intervention to humans.

National recommendations for proper research conduct (Swedish Research Council) and guidelines on information security at the authors' institution were followed. All interview participants were informed of the purpose of the study and that identifying information will not be made available to anyone who is not directly involved in the study. All participants gave their consent and permission to use the photos.

SUPPLEMENTAL DATA

Supplemental data for this article can be accessed at: *https://doi.org/10.5334/bc.120.s1*

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