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Architectural, indoor environmental, personal and cultural influences on students' selection of a preferred place to study

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ABSTRACT

This paper aims to better understand the human inhabitation of buildings through an investigation of the influences of architectural order, indoor environmental as well as personal and cultural variables on student's selection of a preferred place to study. The approach for this interdisciplinary inquiry is based on Integral Sustainable Design in combination with a simplified version of Integral Methodological Pluralism using methodologies from the disciplines of architectural design, architectural science and psychology. The results indicate that participant's preferences emerged out of either personal or collective cultural narratives. The integral approach was useful to identify collective preference patterns as well as deviations from these and to understand why they occur. Important influences on participant's selection of their preferred place to study were spatial characteristics, in particular a balance of prospect and refuge as well as individual past experiences, and the nature of the given task in this case study.

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Integral sustainable design; integral methodological pluralism; occupant behaviour; cultural narratives; architectural order; thermal comfort; visual comfort; prospect and refuge

From occupant behaviour to human inhabitation

The emergence of occupant behaviour as a research field can be linked to the history of comfort expectations and advances in conditioning systems and building technologies, alongside changes in lifestyle (Brager and de Dear 2003; Roetzel et al. 2010). Advances in conditioning systems brought greater occupant control of thermal conditions, triggering research on recommended set points, occupant behaviour and comfort models. This body of research led to the understanding that occupants are not discrete variables to be represented with standard values, but that occupant behaviour is the result of a complex interplay of various contextual variables, best understood through interdisciplinary inquiries (IEA 2018; IEA 2019).

This article presents a pilot study for such an interdisciplinary inquiry employing the perspectives from architectural design, architectural science and psychology. It aims to understand the influences of architectural design and composition, indoor environmental variables and personal cultural background on student's selection of a preferred place to study in a university context.

This research is theoretically framed using concepts from *Integral Sustainable Design* (ISD) (DeKay and Bennett 2011), which is an application of Ken Wilber's Integral Theory (2000, 2001, 2007b) to architectural sustainable design. Generally, integral theories begin with the assumption that everyone is right – at least partially and fashion an intellectual framework that transcends and includes differences. An integrally informed approach to buildings (or anything else) holds multiple simultaneous perspectives to address different levels of awareness across the spectrum of human development. Integral Theory

in Wilber's approach, often called 'All-Quadrants, All-Levels' (AQAL), advocates a comprehensive approach that takes into account in addressing any situation the factors of:

- (1) Quadrants (Worldviews or paradigms, encompassing such elements as experience, meaning, behaviours and systems),
- (2) Levels of holarchic depth (for instance, body, mind, and spirit and developmental levels of consciousness within each),
- (3) Lines of human development or development levels within specific intelligences (such as moral, psychosexual, emotional and cognitive),
- (4) States of consciousness (such as waking, dreaming, deep sleep, meditative, as well as more specific conditions such as stressed, anxious, drunk, afraid, ecstatic, etc.) and
- (5) Types of human personalities (such as masculine and feminine, Myers-Briggs, or other personality types).

This may sound extraordinarily complicated, yet the idea is that this is about the simplest model that can account for or map the complexity of humans and their universe. Using all the AQAL dimensions in a single project would be a heroic task. In most instances, an inquiry can take an *integrally informed* approach, which suggests taking limited perspectives within the context of being aware of larger dimensions that contribute to great holistic understanding. Even in a simple mode of four levels and four quadratic perspectives, one could look at the subject from 16 different perspectives, but in practical applications this is usually unreasonable. In this paper, we will limit our study to the two most fundamental aspects of the integral model: quadrants and to a lesser extent, levels.

	Subjective	Objective
Individual	<p>Occupant experience upper left (UL)</p> <p>What are spatial/temporal patterns of individual occupants experience?</p> <ul style="list-style-type: none"> - Perception and sensation - Personal thoughts, interpretation and meaning 	<p>Occupant Behaviour upper right (UR)</p> <p>What are spatial/temporal patterns of measured conditions?</p> <ul style="list-style-type: none"> - Measurable environmental conditions - Observable individual behaviours
Collective	<p>Group narrative lower left (LL)</p> <p>What are background cultural narratives for individual experiences and behaviours?</p> <ul style="list-style-type: none"> - Cultural narratives and norms - Collective meaning, theory, ideas 	<p>Activity-Space Nexus lower right (LR)</p> <p>What are spatial patterns of formal architectural order?</p> <ul style="list-style-type: none"> - patterns of spatial, architectural order - patterns of social activity, functions, behaviours and use

Figure 1. Four fundamental perspectives on building inhabitation (DeKay et al. 2018).

Wilber's Integral Theory organizes any problem into a matrix that intersects individual and collective phenomena with objective and subjective knowledge. These combined variables reveal the following fundamental perspectives: (1) *Experiences*: self and consciousness; (2) *Behaviours*: science, mechanics and performance; (3) *Cultures*: meaning, worldviews and symbolism and (4) *Systems*: social and natural ecologies and contexts (DeKay and Guzowski 2006). Michael Zimmerman, Tulane philosopher, notes that 'the quadrant perspectives correspond generally to four ways in which universities divide research methodologies (that is, truth-claim generating practices or paradigms): fine arts (UL), humanities (LL), natural sciences (UR), and social and systemic natural sciences (LR)'. (Zimmerman 2004). For the purpose of this project an *integrally-informed* approach was applied to the interaction of occupants and buildings. The term 'occupant behaviour' can be associated primarily with one perspective, that of the occupant behaviour (UR) perspective (see Figure 1), therefore, in this study the term 'human inhabitation' is used instead, which encompasses all four primary perspectives and potentially, all levels.

This article is part of a larger project that investigates the hypothesis that spatial-temporal patterns in buildings can serve as an investigating frame among diverse research perspectives on inhabitation. The study design and research methodology

are described in depth in (*authors*). Figure 1 summarizes the approach developed in *ISD* applied in this project to human inhabitation based on four project perspectives: (1) Understanding individual *Occupant Experiences* and perceptions, the upper left perspective (UL); (2) Objective *Occupant Behaviours* in relation to measurable environmental parameters, the upper right perspective (UR); (3) Acknowledging that these are situated in a context of collective *Group Narratives* and interpretations within cultural narratives, the lower left perspective (LL); and (4) Spatial-temporal contexts of the building and its use, termed the *Activity-Space Nexus*, the lower right perspective (LR).

Integral methodological Pluralism as a research approach

This research is framed using an abbreviated subset of Integral Methodological Pluralism (IMP) (Wilber 2007a, Chapter 1), a meta-paradigm that relates different research methodologies to the four foundational integral perspectives (quadrants) and, within each quadrant, to perspective viewing phenomena disclosed from each paradigm from within its own interior or from an outside, exterior perspective on its knowledge domain. This gives eight 'primordial paradigms', each with its own class of methods.

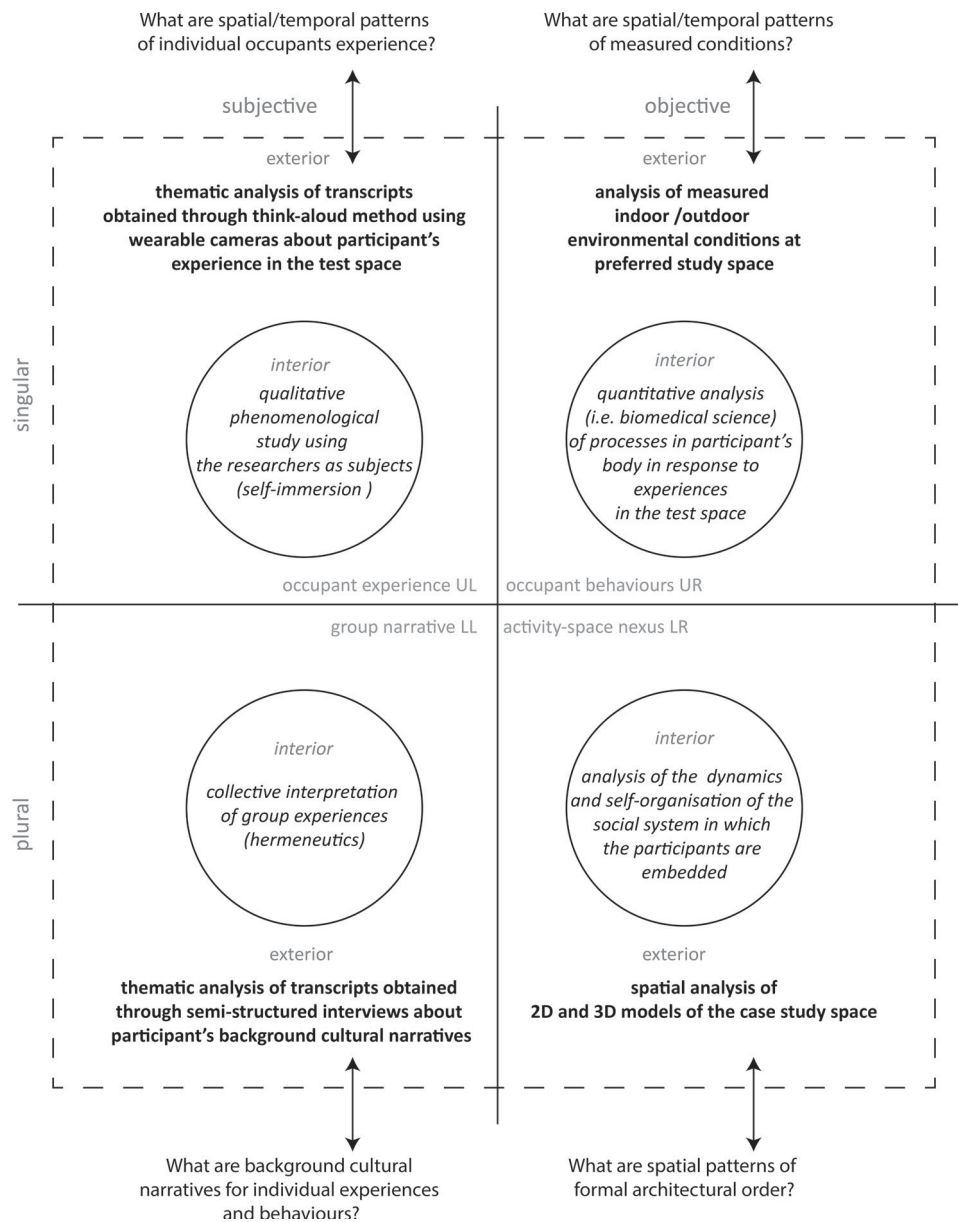


Figure 2. IMP applied to human inhabitation – project research questions with exterior and interior methodologies for each quadrant.

Figure 2 maps the selected research questions and methodologies for this project into the 8-zone IMP framework. It is evident that they are all related to the exterior perspectives within each quadrant. Potential interior perspectives, within the circles and shown in italics, are proposed to demonstrate wider application of the IMP to the human inhabitation of buildings. However due to time and budget constraints, they were not part of this project. For example, a cognitive science approach would help to understand the interior of the behaviour perspective but would require additional expertise and complexity. Instead, we have taken the 'exterior-UR' approach of observing the occupant behaviour and measuring the associated environmental parameters. It reveals the phenomena that its methods allow, but tells us nothing about the brain chemistry or neurophysiology associated with inhabitant choices or other biophysical self-regulation mechanisms affecting the behaviour. To distinguish our methods from the more complexed IMP, and from the

less specific 'mixed methods' terminology, we call our efforts an Integral Research Approach (IRA). Although not as comprehensive as an approach using all eight categories, the selected four methodologies allow for 'integral triangulation' of different data (Divecha 2014) and more holistic results, as compared to single methodologies, allowing the research team to first gain experience using this simplified IRA.

Figure 3 summarizes guiding research questions, data collection methods and data analysis methods in each of four quadrants. From the Occupant Experience (UL) perspective, data were obtained using the think-aloud method, a qualitative methodology commonly used within psychology to understand the way in which individuals think about themselves, others, and their social environment (Eccles and Aarsal 2017). It provides an overview of what participants think in real-time as they experience various social environments and interact with others. Thus, it provides an in-depth understanding of the cognitive

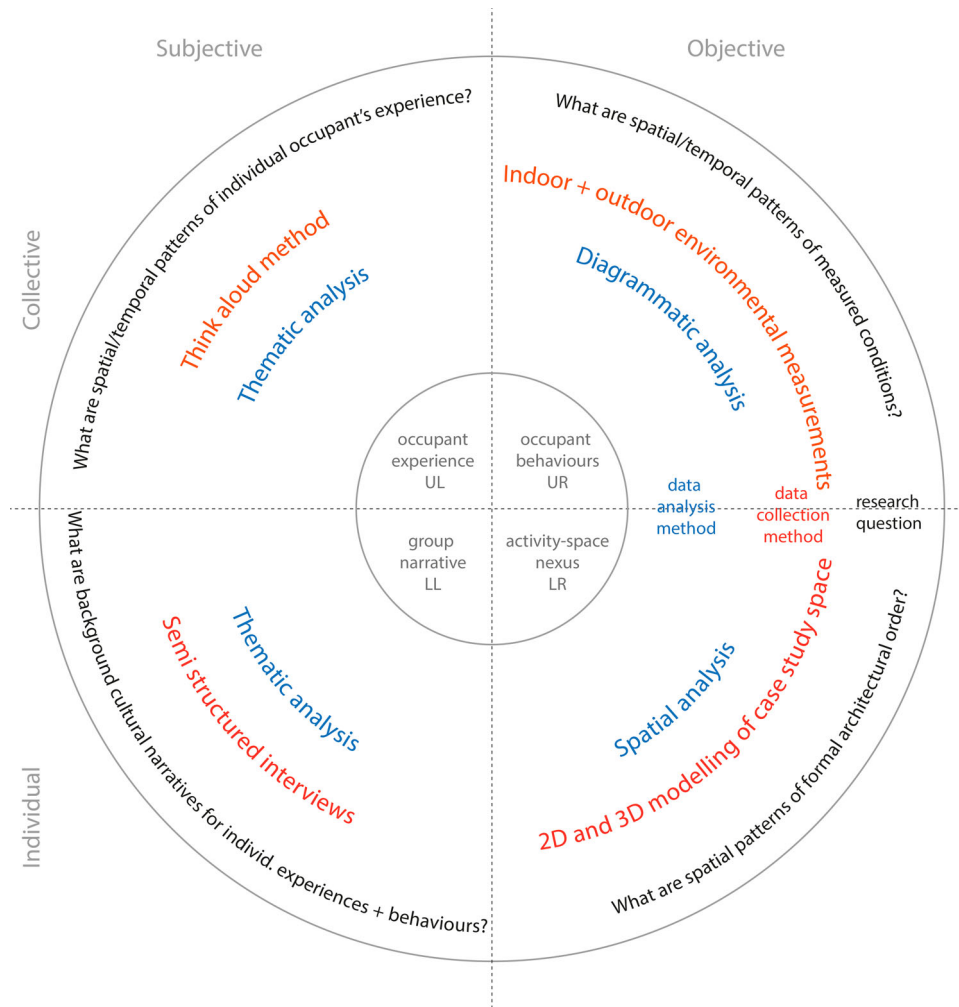


Figure 3. Research questions, data collection and analysis methods from four perspectives.

processes that may be in play when individuals experience specific physical environments. In the case of this study, participants walked through the test space fitted with a wearable camera mounted on their heads. They were instructed to talk aloud about their thoughts and experiences in real-time while the camera recorded the audio of their speech along with a video.

From the perspective of Group Narratives (LL), the data were obtained through semi-structured one-on-one interviews (Braun and Clarke 2006, 2013) which enable a rich exploration of participant subjective perceptions. A number of open-ended questions about participants' past experience and cultural background were used as prompts for the interview, with probing and follow up questions orientated towards participants' responses employed to fully explore participant perceptions. This flexible approach was used to ensure that the interviews yielded in-depth and meaningful responses (Jacob and Ferguson 2012; Braun and Clarke 2013).

For both the think-aloud and interview data, the audio recordings were transcribed and analysed using 'thematic analysis' (Braun and Clarke 2006, 2013). This qualitative methodology permits the identification of consistent patterns across participant responses, thus allowing for a richer understanding of their shared perceptions and views of their social environments. In accordance with Braun and Clarke's six-phase methodology for

thematic analysis (Braun and Clarke 2006, 2013), the interview data were analysed using a reiterative process of identifying, interpreting and analysing common themes across participant discourses. Categories and codes were inductively constructed by close readings of the interview transcripts (Morse 2008), with the research questions developed from the *Integral Sustainable Design* framework then used as a guide for identifying the shared themes across participants during formal analysis. The data were collapsed and presented together as they were found, there were little differences in how participants discussed the physical space during the think-aloud procedure and semi-structured interviews. Utterances that did not add any extra meaning to the participant's quotes have been removed during the data analysis.

From the Occupant Behaviour perspective (UR), environmental parameters were measured at the participant's preferred place to study: air temperature, globe temperature, air speed, CO₂ concentration and relative humidity. Illuminance was measured using a handheld lux metre. The mean radiant temperature, operative temperature and thermal comfort were calculated and assessed by ASHRAE Standard 55-2017 using the Comfort Tool (Hoyt et al. 2019). Live noise and background noise were measured with a class 2 sound level meter but not simultaneously with the environmental parameters. Live

noise was measured on other representative days during regular school hours and followed the measurement time sequence from the previous field measurement. However, the background noise was measured on a weekend when the spaces were unoccupied.

From the perspective of Activity-Space Nexus (LR), a 3-D CAD model of the case study space was built, including the elements of spatial architectural order, furniture and textures, indicating the materiality of major surfaces but excluding the aspects of temporal variability. From each participant's viewpoint at their preferred place to study, a series of screenshots were taken representing a 360-degree panoramic view and the drawings were assessed for spatial characteristics of prospect and refuge. The analysis did not commence through a lens of prospect-refuge theory. Rather, the principles of prospect and refuge emerged through the analysis of the spatial characteristics as well as participants' voices.

Prospect and refuge theory

Prospect-refuge theory (Appleton 1996) proposes that innately, humans prefer and seek places that provide safety (refuge) and offer the ability to survey territory without being seen (prospect). Hildebrand (1991) applied the theory to the houses of Frank Lloyd Wright and identified several architectural features that

he associated with prospect-refuge. He also proposed the idea of internal prospect-refuge, that is, not just the protected view to landscape but from one interior space to another. Hildebrand's thesis is that survival-driven instinctual preferences can influence some aspects of contemporary architectural pleasure.

The theory has been applied in environmental psychology, interior design, architecture and landscape architecture and is the subject of numerous research studies, yet there is 'only limited empirical evidence to substantiate the theory' (Dosen and Ostwald 2013).

The case study space

The communal spaces of the main building at the Waterfront Campus, Deakin University, in Geelong, Australia, served as a test space. Its spaces differ in spatial and environmental features, as illustrated in Figure 4. Indoor spaces are air-conditioned. The participants had no access to building controls.

A total of 20 people aged 20–57 participated in the research project (12 women, 8 men). Participants differed in their country of birth (South Asia = 3, South East Asia = 1, Australia = 11, China = 4, South America = 1), but the education level was relatively homogenous (postgraduate students = 13, undergraduate students = 7).

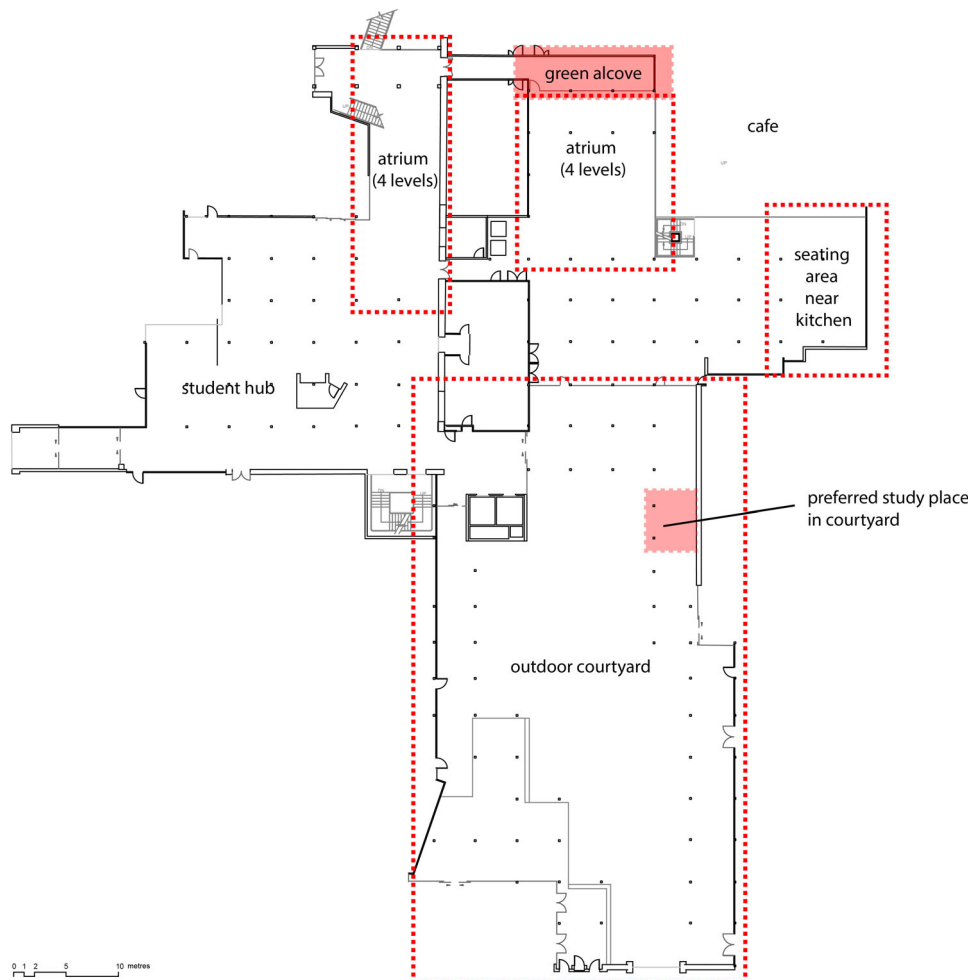


Figure 4. Floor plan of the case study area with the two most popular spaces shaded.

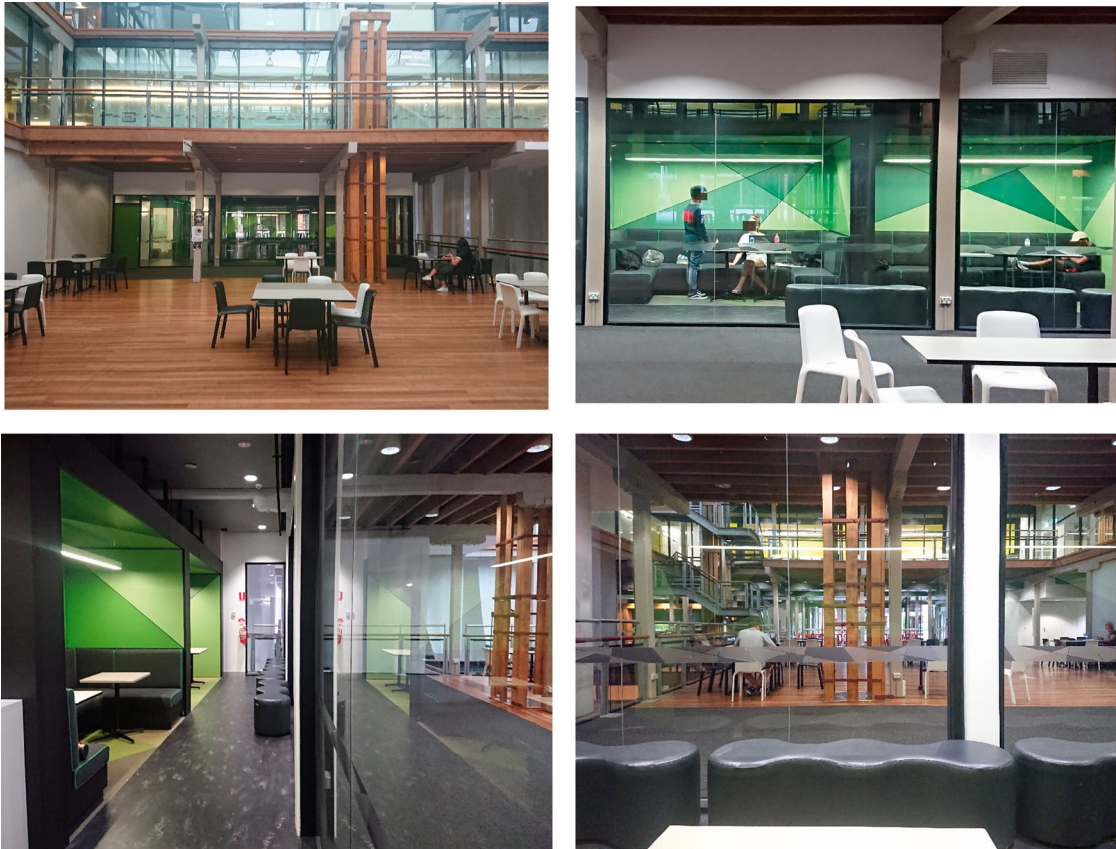


Figure 5. Views from atrium to green alcove (upper), into green alcove from inside glass wall (lower left), and out from green alcoves (lower right).

Preferred places to study by the 20 participants were clustered in five different locations. This paper focuses on the 'green alcove' (7 participants) and the courtyard (4 participants) only, as these were the most popular spaces.

Occupant experiences and background narratives

The green alcove

The green alcove, located underneath a balcony, faces a four-storey atrium. It consists of two study 'nooks' with a view to the atrium through a glass wall (Figure 5).

Spatial preferences

The participants who selected the green alcove as their preferred place to study appreciated the space for offering *prospect* (being able to see others and survey activities) as well as *refuge* (a feeling of safety from being partially isolated and seen less). Refuge was associated with spatial characteristics and the reason why refuge was sought. Key spatial features contributing to the perception of refuge were:

- *Small and confined space*: 'For me, study is definitely about ... I don't mind background noises, but I definitely like a little, kind of, comfortable confined space'. (A09, Video-recording)
- *Cave-like geometry with protecting walls on all but one side*: 'The green is particularly good quality space to be in ... it was secure so I mean there's no one behind you so you're secure

that way, you're closed on three sides and a nice view out ... ' (A11, Interview)

- *Internal glass wall separating the green alcove from adjacent atrium*: 'You can see things from outside. But you [are] actually being protected by the, your surroundings ... ' (A21 Video-recording)

While the appreciation for the protection of this arrangement was shared among the participants, there appears to be different reasons why protection is sought:

- *Refuge from other people who are perceived as a threat to one's privacy*: 'I'm aware of what's going on out there but there's no invasion on me, on my privacy and on my senses. I have total privacy, well, I mean, I can sit here, and nobody would know what I'm doing'. (A09, Video-recording)
- *Refuge from study-distracting, overstimulating visual content*: 'I don't like to see others ... I can't control myself and I would be distracted to see them. So, of course, I can't finish my tasks'. (A14, Interview)

Prospect is associated with perceived stimulation by visual content while refuge is sought from more extreme degrees of stimulation, yet a lesser degree of stimulation appears desirable by the participants. Prospect was sought for:

- *The ability to observe other people*: 'I have total privacy, well, I mean, I can sit here, and nobody would know what I'm

doing. But I can see what everybody else is doing'. (A09, Video-recording)

- *Being a source of visual interest and stimulation:* Interviewer: 'Do you have any thoughts about being able to observe everything around you to be important?'
A09: 'It was interesting I suppose but may be I shouldn't have as may be it's a distraction. It was interesting. It was visually interesting'. (A09, Interview)
- *General oversight:* 'Yeah, so you can see from the inside you can see what's going on the outside . . . you can see the people close in the courtyard, but in the building, but you can also see what's happening in the courtyard so it's kind of protected but it's quiet . . . '. (A21, Interview)

The desired balance between the prospect and refuge seemed dependent on the study task itself, with more concentrated tasks requiring a higher degree of refuge and less concentrated tasks being associated with much prospect:

If I'm studying like a very serious thing then I would prefer a bit more . . . isolated space to study in which topic I have to put a lot of concentration, if I'm doing . . . a little bit of study work or studying novels . . . , then I would preferably like to have my back on the wall and see people and also study because . . . I may see some of my friends. (A22, Interview)

Architectural ambience

Several participants mentioned the attributes of architectural ambience as influential on their selection. The green wall colour was a theme that was interpreted similarly by two participants, who mentioned the symbolic reference to the nature:

You know in agriculture and [inaudible] culture, I mean green's mostly associated with the good season, the healthy season (A11, Interview).

Apart from colour, architectural details were noticed by one participant—in particular, referring to the complexity of the structural order of the atrium:

But, again in terms of structure and architecture, it's very interesting, all the detail to look at. (A11, Video-recording)

Participant A03 associated the childhood memories with the courtyard visible from the green alcove:

Open courtyards, which is a really great move, when I actually came to university my parents they all said kind of like our old house in India (A03, Interview);

Furniture

Another theme from the thematic analysis of the walk-through and interview data are the characteristics of the furniture:

I definitely look at the shape of the chair. There's a lot of really poorly designed seating, because I have a lumbar injury. (A11, Interview)

This reflects how standard sized furniture may not be suitable for every occupant, which is also emphasized by another participant:

A21 And if, if the, the seat I choose soft, I probably would put books below me to . . .

Researcher To sit on the books?

A21 Yeah.

Researcher Oh, because it's too low?

A21 yeah (A21, Video-recording)

For participants who selected the alcove, the seating comfort, particularly softness, played a role: 'This sofa, it's soft' (A14, Video-recording), along with the warmth of the fabric:

But, for me, warmth is also, like, . . . I'm sitting on a . . . fabric that provides, like a comfort, like a warmth. (A12, Video-recording)

Participant A12 mentioned that the furniture evokes the childhood memories of activities, with studying being associated with the furniture that is not overly comfortable:

For me it's . . . it's a comfortable chair . . . not necessarily like sitting on a couch because I think I get too comfortable and it's an association of the TV and the couch as like a reward. (A12, Interview)

Indoor microclimatic preferences

From the indoor microclimatic parameters, the most important appeared to be the acoustic environment. For some participants, acoustics was more important than lighting:

I prefer to choose a place quiet then, rather than something bright 'cause I'm easily to be distracted. (A14, Video-recording);

or the amount of visual distractions:

My I guess preference was to choose something with the noise that was probably more important and also for the comfort of me and then not having visual distractions. (A12, Interview)

For studying, all participants aimed to avoid acoustic distractions, e.g. 'study is . . . more refined and quiet' (A12, Video-recording). The green alcove offered some sound protection via the glass wall separating it from the noisier atrium: 'Cause with this glass, ah, you can't hear the noise from outside' (A14, Video-recording). It offered the possibility for further acoustic adaptation by closing the door: 'Soundproof, kind of. If you close that door, that would be not much sound left' (A21, Video-recording).

Several comments suggested that noise quality was important, in particular, a differentiation between the background noise and disruptive noise, which can impact the concentration:

Noise doesn't worry me when I'm studying, I don't think. Except may be really disruptive noises and abrupt noise. (A09, Video-recording)

Another participant's comment further qualified the nature of disruptive noises: 'Yeah, because it's, you don't hear the footsteps and you don't hear the stairs or the music' (A03, Video-recording).

In terms of lighting, all the participants mentioned a need for sufficient light for study: 'One thing I really need is light. Um, I need to be able to read when I'm studying' (A09, Video-recording). As illustrated in Figure 6, light levels in the green alcove varied by more than 100 lux, depending on the interplay of natural and artificial light. Participants commented on illuminance, light distribution, colour and overall quality. Further investigation would be interesting to evaluate what role the relative differences in lighting quantity and quality played in participant's selection of their study space.

With regard to temperature, several participants referred to the green alcove as cool: (A03, Interview), 'I found that place to be very helpful to be, 'cause it was all lot cooler', and:

Participant	Illuminance [lux]	Subjective comment	Objective parameter
A11	269	(Go pro) The light levels are very good. There is a lot of green light which seems quite comfortable.	Illuminance Colour temperature
A03	288	(Go pro) Yeah, it's pretty good. Really good actually, for studying.	Overall quality
A12	323	(Go pro) I like the lighting, and I think it definitely is... It's definitely good that it's direct because you do need that, kind of, direct light shining on... On your page when you are studying. But I don't like its intensity when I'm looking up at it, or how it, kind of, flushes the box, or the... The, um... The nook space either. It's too intense for me.	Light distribution, Illuminance
A22	332	(Interview) The place that I have picked it's both a bit bright and also a bit you know like a lot of people is in front of me but I can't hear them properly because that space has a glass	Illuminance
A14	360	(Go pro) for the brightness, ah, it's not so bright.	Illuminance
A09	379	(Go pro) Um, the light's fantastic, if the light were dim that would put me off.	Illuminance
A21	393	(Interview) So I prefer maybe cold light but not that intense I mean, a stronger light is suitable for me but I don't really care. It doesn't have to be natural light. Natural light sometimes the cloud is blocking there will be "oh much brighter" then it's dim and it's not good.	Colour temperature Illuminance

Figure 6. Objective measurements vs subjective comments on lighting.

Obviously, it's, like, physically, it is that bit cooler with ... With the HVAC system on, I can feel the air conditioning coming down. (A12, Video-recording)

This cooler temperature appeared to be preferred. Participants A09 and A14 considered clothing adaptation in case they felt too cold:

And for the temperature, ah, it's quite cold for me and ... But it's, it's easier to handle. You can just take another coat. (A14, Video-recording)

The courtyard

Within the courtyard, two locations were selected by participants, both under the shade of the balcony, either facing a wall or sitting alongside a wall (Figure 7).

Thematic analysis of transcripts from interviews and wearable cameras revealed five key themes: the climate zone in which the participant grew up, lifestyle, comfort expectations, spatial preferences and microclimatic preferences.

Climate zone of origin

The demographic questionnaire revealed that all 5 participants who selected the courtyard as the preferred place to study had spent most of their lives in the state of Victoria, Australia, Koepen climate zone Cfb (temperate without dry season, warm summer) (Peel, Finlayson, and McMahon 2007). This is the same climate zone as the Waterfront building. The climatic characteristics of this zone are likely to have influenced the participant's lifestyle and the comfort levels to which the participant became accustomed.

Participant lifestyle

All participants who selected the courtyard as a preferred place to study mentioned spending a lot of time outdoors as children, exposed to the same climatic conditions as the case study space. Most of them indicated that they spent more time outdoors than indoors, when growing up:

We definitely spent a lot of time outdoors as kids as well like on the farm probably didn't spend much time inside. (A05, Interview)

We'd be out in the backyard or be out and about or if no sort of, had one TV between 7 and no mobile phones, iPad screens so we were out and about (A15, Interview).

It appears that in doing so they developed a habituation:

The intensity of the sun as well outside, I definitely felt that but because I have been outside a lot of my life, it wasn't much of a shock (A02, Interview).

Some participants referred to general preferences for the outdoors:

... by growing up by the beach and like, and being a surfer especially like how much by doing that you come to like be aware of the conditions around you, like what the wind's doing, what the tides do you know what direction you're facing ... (A05, Interview)

Others were more specific in their preference being attributed to specific aspects of the outdoor environment:

I always think how much I like the fresh air so, even in the car I can't stand the air-conditioning.

Every time I go to someone's house or a building that I feel doesn't have enough air in it or natural light I feel really uncomfortable. (A06, Interview)



Figure 7. Study location for participant A15 (upper images) and for participants A02, A04, A05, and A06 (lower images).

Comfort expectations

The built environment played a role in shaping participant's comfort expectations. All participants made remarks that suggest that the houses in which they grew up in had thermal conditions that followed the outdoor climate, e.g.:

When I was growing up, it varied significantly, so in winter it was cold and summer it was hot, Mum wasn't keen on using the electricity. (A04, Interview)

This is likely a result of the temperate climate (Australian Bureau of Meteorology 2019) in combination with Victorian building regulations, where mandatory insulation in new houses was only introduced in 1991. The majority of the existing building stock is uninsulated (Sustainability Victoria 2015), single glazed (Sustainability Victoria 2017) and has infiltration rates of about 2 air changes per hour (ACH), due to leakage (Sustainability Victoria 2015):

Well we didn't have air-conditioning when I grew up, we had fans and basically utilized the building as best as possible. And then when we needed to we'd bring in the fans or something like that or go for a swim. (A06, Interview)

I find this fascinating because we only had one wood heater as in open fire place so there was no heating anywhere else in the house and my mum was brought up in Tasmania so she would say you know if we were cold, put another jumper on (A15, Interview)

As a result, these participants would, when stepping out of the house, not experience a change as dramatic as from a highly controlled indoor environment to the outside.

Spatial preferences

During interviews, the participants were asked to reflect on the selection of their preferred place to study. The predominant spatial characteristics, all participants were looking for, were those driving a sense of refuge and prospect. Refuge was associated with spatial relationships between a person and the surrounding architecture:

- *Alongside a wall of the courtyard for privacy:* 'Whenever I study I always try to be private so I chose off to the side so that it is more private'. (A02, Interview);
- *Having the back to the wall for protection:* 'I found myself looking for some kind of protection, so, yeah, little people walking through, back against the wall'. (A04, Interview);
- *Facing a wall to avoid distractions related to the view content:* 'There's a couple of areas that you know I probably preferred the actual vista but I didn't know that it would necessarily be as conducive to study as the one that I chose which was more sort of a blank brick wall where I thought you know probably would put my head down and get some stuff done'. (A15, Interview)

Prospect was associated with

- *The possibility to observe the environment:* 'When I study or sit somewhere my preference is sitting down but facing out to the courtyard rather than facing the other way, against a wall or against a door. I don't like distractions but I always

like sometimes to see what is going on and to have that full vision'. (A02, Interview)

- *A sense of spaciousness*: 'I felt more comfortable in the larger open spaces', (A05, Interview)
- *Safety*: 'You've got to feel safe and you've got a quick escape route in emergencies'. (A06, Interview); or
- *As a source of distraction* (A15 above).

Outdoor microclimatic preferences

The participants commented on specific microclimatic conditions that attracted them to the courtyard. In particular, several participants appreciated the air flow or 'breeze' in combination with other parameters, such as lighting, temperature and or air quality i.e.:

Yeah so definitely the ventilation and the air and the light quality out there and yeah I think ventilations, I like the movement of air, not strong winds but I like the breeze. Yeah I feel refreshed when I'm outside (A06, Interview).

In terms of temperature and light, it, it's probably the best because you do have that airflow because it is outside, but it is undercover, so that, that light isn't getting through. (A02, Video-recording); and also

Participant A15 mentioned the possibility of clothing changes or spatial migration as a means of adaptation if the conditions changed:

If it was much cooler, you know I would have to have my jacket on and I probably if it was much windier than today, um, I, I would choose somewhere inside yes. But on today's conditions I think it's very pleasant out here yes. (A15 Video-recording)

In terms of lighting conditions, the participants were avoiding glare, and it can be assumed that in the outdoor courtyard this refers to direct glare from the sun as opposed to the reflected glare, as the surrounding surfaces at the preferred study locations were of low reflectivity (red brick, timber, exposed aggregate concrete) 'It's got a bit of, a nice bit of natural light, but it's not glary. So it's just kind of a bit subdued', (A15 Video-recording) or they were avoiding fluorescent light: 'I don't like fluorescent lighting, I find it irritating'. (A06 Interview)

Most participants pointed out a difference in 'air freshness' between the indoor and outdoor spaces; either due to a preference for fresh air outdoors, 'Outside fresh air was noticeable straight away but restricted inside' (A02 Interview) or a dislike for indoor smell:

- *Health issues*: 'I think it affects my breathing and I think I have a, there's history of respiratory issues . . . '. (A06, Interview); or
- *Unpleasant memories*: 'It's like . . . if you'd go . . . visit your mums work or something like that. It had that smell of superiority'. (A04, Interview)

Another microclimatic characteristic preferred by most participants was quietness. Noise was associated with either:

- *An obstacle for concentration*: 'I prefer quiet study so, um, I don't like to be around too much noise. I can't concentrate otherwise'. (A06, Video-recording); or
- *An invitation to communicate with others*: 'And it's pretty quiet too, so generally I can get a bit of study done and not get stuck talking to too many people'. (A05, Video-recording); or

- *An obstacle to create an own acoustic environment*: 'I like it a bit more quiet to study and I like just a little bit of music. So I could probably put some headphones on and have a bit of music here I'd be okay'. (A15, Video-recording)

The absence of noise was associated with:

- *Peacefulness*: 'Definitely between this space and then just going immediately outdoors. It, kind of, just got trapped behind me, the sound. Um, and then it was instantly a lot more quiet and peaceful'; (A02, Video-recording)
- *Distraction*: 'And it's quiet, but it's not too quiet to drive yourself to distraction'. (A04, Video-recording)

Spatial patterns of the formal architectural order of the preferred places to study

Architectural order – green alcove

Within the green alcove, three different locations to sit were chosen. The alcove consists of two study nooks with a cave-like geometry looking into the adjacent atrium, with built in seating having a cushioned felt-textured cover along the perimeter of each space, around a white-surfaced table in the centre. All seating has a backrest. Each of the two study nooks has green wall panels, a pendant luminaire providing direct down lighting, and receives some daylight from the adjacent atrium.

The 360 degree montage of view (Figure 8) from the participants' preferred place to study shows that roughly half of the 360 degrees were covered by surrounding walls on the participants back or sides, providing a sense of refuge. The remaining view angle provided prospect looking into the adjacent atrium, however the observer is semi-protected from behind the glass wall. High-backed booths provide refuge with minimal inhibition to prospect. The space highlights many of the practical applications of the prospect-refuge principle:

Refuge:

- Accessibility is limited to two doors which can be closed
- Ceiling is lowered to create 'cave-like' refuge contrasting the four-story atrium
- The space is set with both a side and back wall
- A glass wall, offering acoustic protection and limiting access to the study nooks

Prospect:

- Clear lines of sight in front of seating through atrium space towards courtyard
- Glass wall enabling a view towards the atrium and courtyard
- Difference in scale between the green alcove and the adjacent atrium, giving a sense of a view from a smaller space looking into a larger space
- Architectural detail and lively activity in the atrium, providing interesting view content

Architectural order – courtyard

The preferred study places are located underneath a balcony, alongside a façade enclosing the courtyard. The participants had

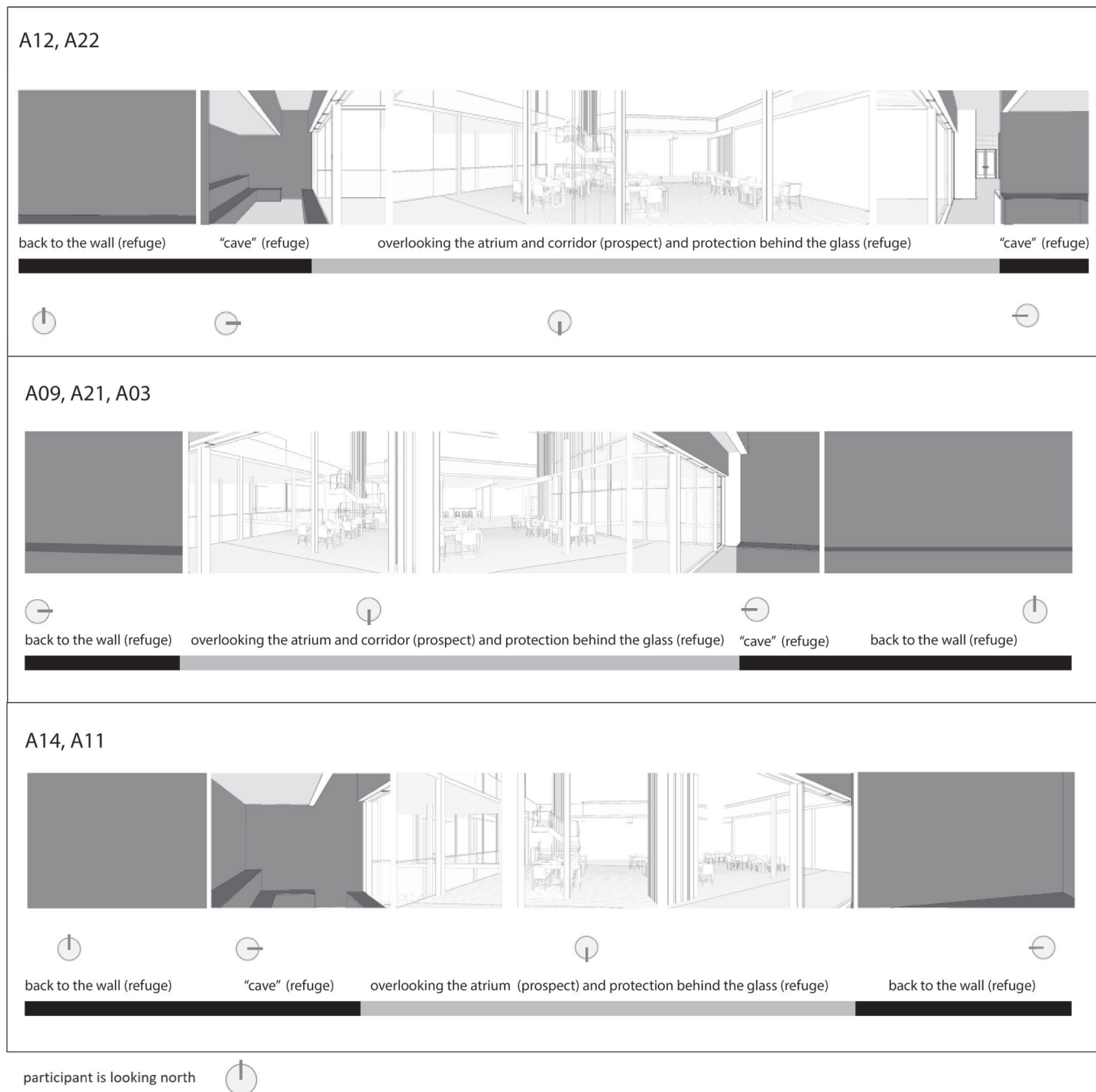


Figure 8. 360 degree views from three different sitting locations in the green alcove.

a view into the courtyard but are not exposed to the elements, being sheltered from the direct sunlight, which makes the seating area darker than the adjacent court. The tables and benches are metal with a timber surface cover and the benches have no backrest.

With one exception, all participants selecting the courtyard chose to sit in exactly the same spot (Figure 9). This location offers a balance between the prospect and refuge, whereas participant A15 selected a location which was predominantly focused on refuge rather than prospect (Figure 9).

The main architectural order contributing to the perception of refuge is:

- Balcony coverage, limiting ceiling height and creating a cave like configuration
- Row of columns offering separation from the larger court
- The wall that participants chose to sit alongside
- A corner situation at the back either created by the rubbish bins or courtyard corner
- Facing a wall and with the back to the courtyard as refuge from visual distractions (A15 only)

The main architectural order contributing to the perception of prospect are:

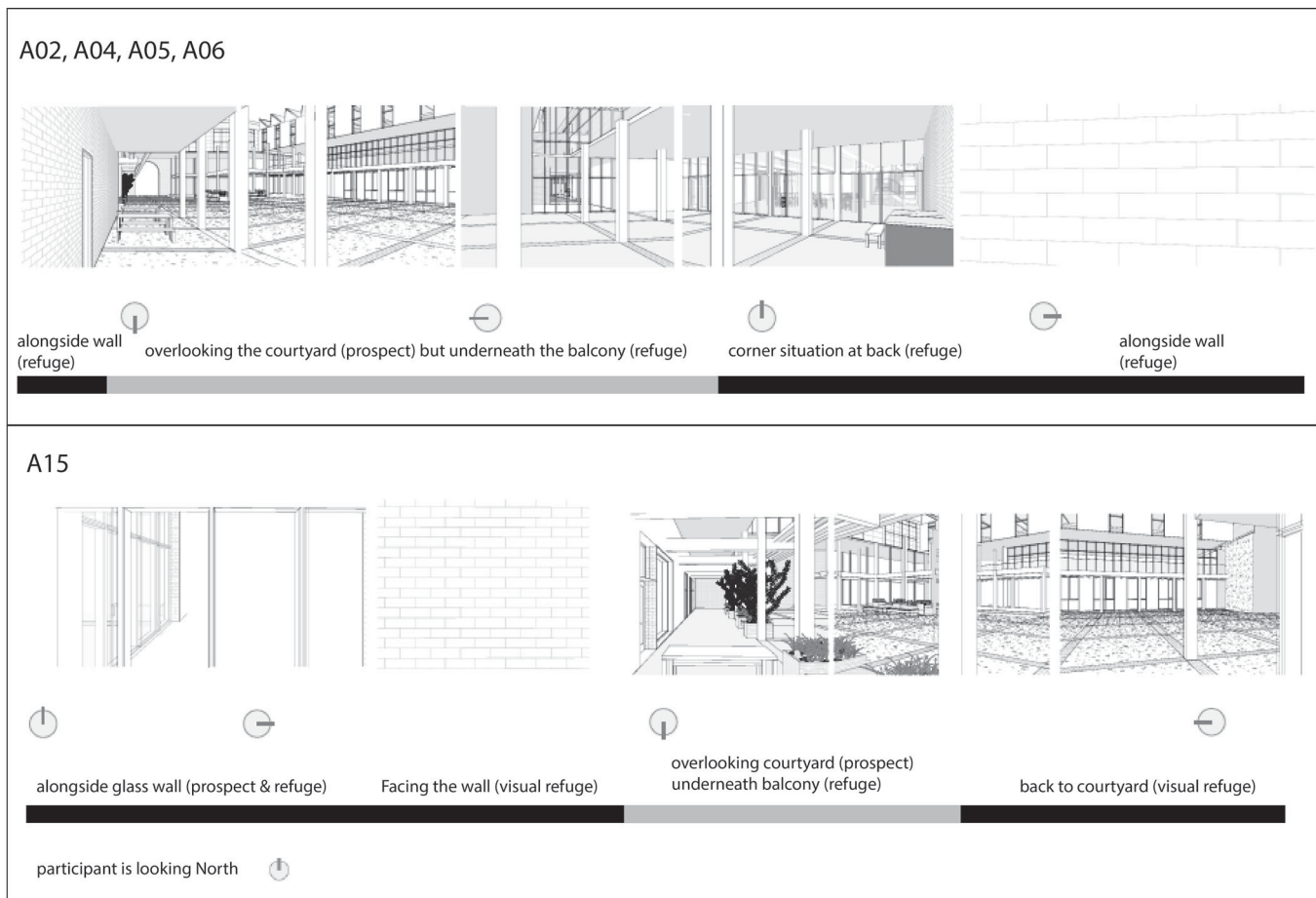


Figure 9. 360 degree views from two different sitting locations in the courtyard.

- Overview of all entrances to the courtyard
- Difference in scale between the refuge location and the courtyard
- The intricacy of architectural details in the view content of the courtyard

Measured indoor / outdoor environmental conditions (UR)

Background and live noise

Background noise in the green alcove was significantly lower (see Figure 10) compared to the courtyard which was expected considering the impact of air-handling units on the roof and other uncontrollable outdoor noise sources. Although the difference between background and live noise in the green alcove was relatively higher, it was mainly attributed to occupants' activities within that space. Live noise in the courtyard might be perceived as less distracting due to the masking effect of high background noise and the less variable nature of both noises.

Temperatures, humidity and air velocity

Figure 11 shows the operative and outdoor temperatures for the two locations. The operative temperatures were similar in both spaces and for the indoor green alcove they were within the recommended ranges in ASHRAE 55-2017.

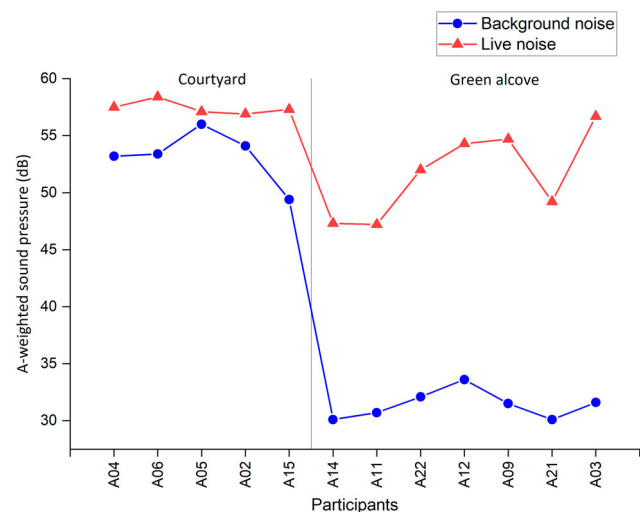


Figure 10. Background noise and live noise for courtyard and green alcove.

Figure 12 shows the air velocity and relative humidity for the courtyard and green alcove. Air velocity varied substantially between the two spaces and was generally higher in the courtyard. The relative humidity levels less varied between the spaces and for the indoor space within recommended ranges in ASHRAE 55-2017. The elevated air velocities in the courtyard made it feel cooler than the green alcove. Participants A06, A02 and A15, for example, referenced the relatively high air velocity

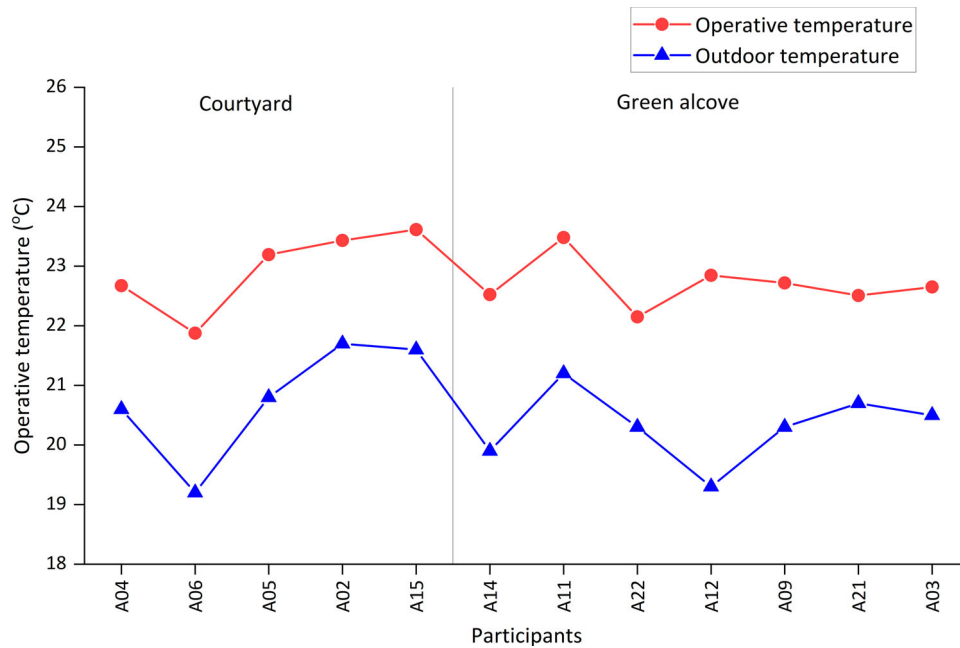


Figure 11. Operative and outdoor temperature for courtyard and green alcove.

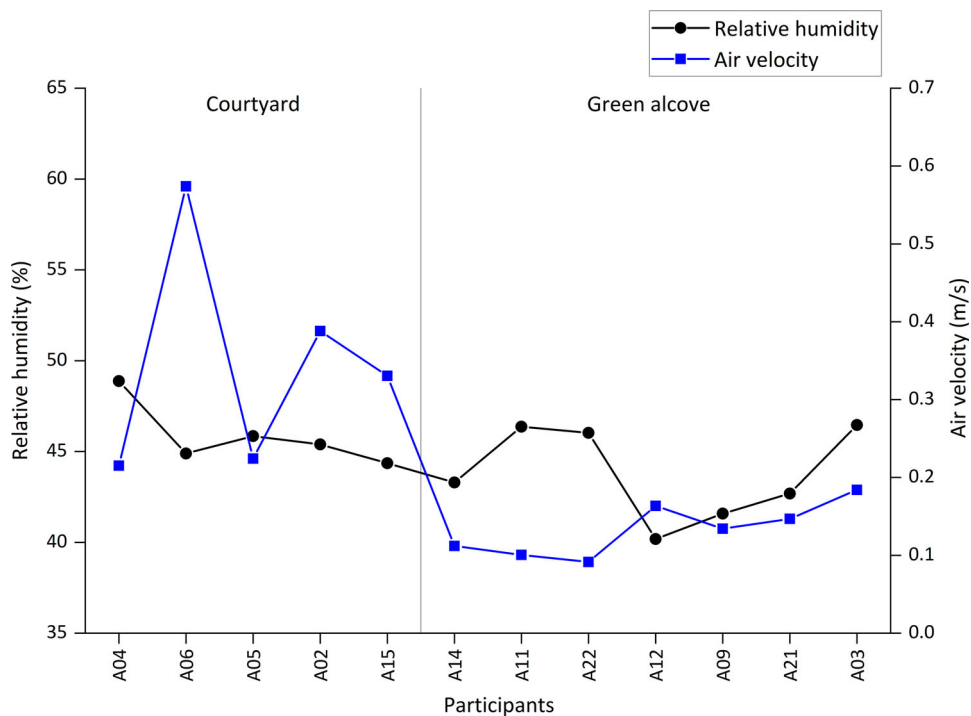


Figure 12. Air velocity and relative humidity for courtyard and green alcove.

as influencing their selection. This is likely an instance of alliesthesia where these participants appreciated the cool breeze of the shaded courtyard in contrast to the sunny and warm-radiant open courtyard and the relatively stuffy and warm indoor environments.

Although operative temperatures for the seven participants in the green alcove did not vary substantially, the thermal environment experienced by four of the participants did not comply with ASHRAE 55–2017 based on calculations using the University of California Berkeley, Centre for the Built Environment thermal comfort tool (Hoyt et al. 2019) (Figure 13). This was

likely due to the influence of air velocity and relative humidity on temperature or other factors, like metabolic rate during the study. The thermal environment experienced by all respondents who preferred either the courtyard or the green alcove seems to suggest a wide range of thermal preference.

The universal thermal climate index (UTCI) was calculated for the courtyard using the Leibniz Research Centre for Working Environment and Human Factors UTCI online calculator (Wojtach n.d.). The UTCIs were A04 = 22.5°C, A06 = 21.7°C, A05 = 22.8°C, A02 = 23.3°C, A15 = 23.2°C and all within the thermal stress range of 9–26°C.

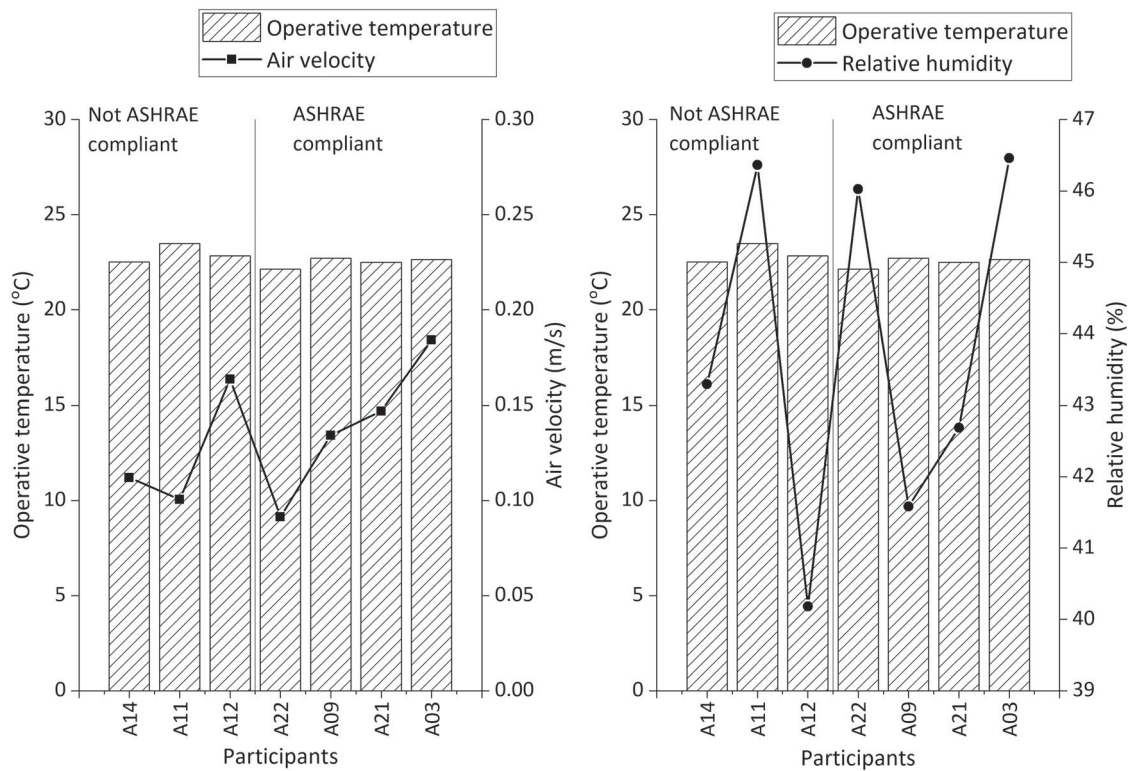


Figure 13. Operative temperature, air velocity and relative humidity for participants who selected the green alcove.

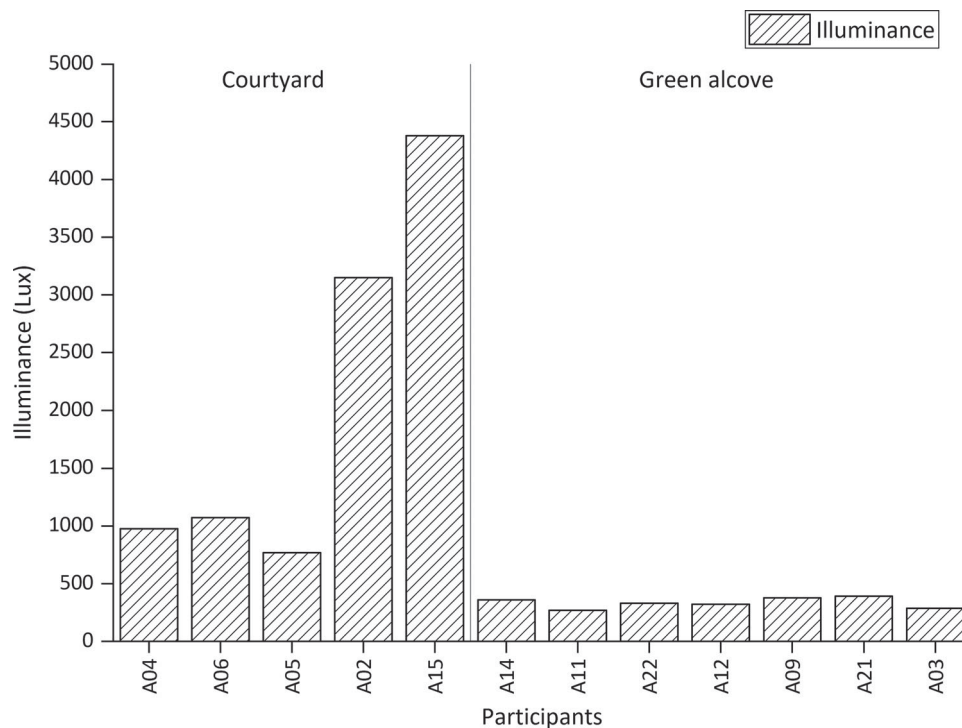


Figure 14. Illuminance levels for the courtyard and green alcove.

Lighting

Given the difference in illuminance between the courtyard and the green alcove (Figure 14), it seems that the participants had different expectations of visual comfort for indoor and outdoor spaces. However, the lighting levels experienced by

all the participants were with two exceptions above or well above the recommended minimum illuminance of 320lux for moderately difficult tasks (AS/NZ 1680.1:2006). Although the five courtyard study locations were shaded, the significant difference in illuminance was due to solar altitude and azimuth

Table 1. Influencing themes from three quadrant perspectives that shaped participant's preferences for occupant experiences (UL), as derived in this study.

Influence on preferences	Themes driving preferences	
	Green alcove	Courtyard
Spatial order (LR)	<ul style="list-style-type: none"> • Prospect and refuge • View • Proximity to other people and amenities 	<ul style="list-style-type: none"> • Prospect and refuge • Memories of similar building types
Material details (LR)	<ul style="list-style-type: none"> • Colour • Complexity of compositional order • Memory of details with positive associations • Feelings (ambiance) 	Not mentioned
Furniture (LR)	<ul style="list-style-type: none"> • Ergonomics • Comfort of design 	Not mentioned
Local microclimate (UR)	<ul style="list-style-type: none"> • Acoustics • Lighting • Temperature 	<ul style="list-style-type: none"> • Air speed • Lighting • Temperature • Air quality • Noise • Humidity
Climate zone of origin (UR)	not mentioned	<ul style="list-style-type: none"> • All from climate zone: Temperate, without dry season, warm summer (Cfb), (Peel, Finlayson, and McMahon 2007)
Lifestyle (LL)	not mentioned	<ul style="list-style-type: none"> • Outdoorsy upbringing • Preference for outdoors • Accustomed to large diurnal range indoors and to seasonal variation indoors

at the time of measurement. The location A15 with illuminance of 4380 lux was measured at 2:19pm and had substantial direct sunlight (altitude = 52.05°; azimuth = 340.38) while the location A02 with illuminance of 3150 lux was measured at 12:18pm and had substantial reflected sunlight (altitude = 50.00°; azimuth = 29.27°). The other courtyard locations were measured earlier or later than A15 and A02 when solar altitude was relatively lower.

Discussion

Table 1 summarizes the themes that influenced the participant's preferences for a particular study location. In this framing, methods from the perspectives of UR Occupant Behaviours, LR Activity-Space Nexus, and LL Group Narratives generated an understanding of influences affecting individual participant choices, an UL interior affair.

Prospect and refuge, as well as lighting and temperature and architectural influences on these, were influential themes for the selection of both spaces, whereas the other parameters were influential for only one of the spaces. This could potentially suggest that some parameters are related to the basic functionality of the human body in general and apply to all healthy humans, i.e. due to the fact that body temperature and the visible light spectrum are more or less similar for healthy adults. The same might apply to the perception of prospect and refuge as a basic human instinct. Both the study locations had an architectural order that offered some form of cave-like geometry of semi-enclosure as refuge but also allowed the participants to observe their surroundings (prospect). These parameters can explain the similarities in preferences. It appears that safety, security and control outweigh many other factors and might be considered more fundamental (Maslow 1943, 1962).

Other parameters, such as the climate zone of upbringing, comfort expectations, memories associated with particular conditions based on past experiences and symbolism of colours are related to the specific context of individuals and could explain

deviations in preferences. One such deviation was observed for the part of the participant cohort who grew up in the same climate zone as the case study, had an outdoorsy upbringing and was accustomed to home indoor conditions that closely responded to the outside climate due to poor insulation and heating. This cohort voiced a preference for 'fresh air' as opposed to air-conditioned interiors, preferred the higher air velocity as a pleasant 'breeze' and thus preferred the courtyard over an inside location.

The study also revealed that the task of studying somewhat predefined the preferences, in particular for a quiet and well-lit but not glary space and the specific balance between prospect and refuge. Some participants further suggested different spatial preferences and furniture ergonomics for relaxed reading vs. highly concentrated work.

From LR Activity-Space Nexus perspective results, we find that the two study spaces most commonly selected offered architectural characteristics suitable for study purposes at the time the participants were in the building. With regards to the UR behaviours perspective, the green alcove is provided with full mechanical climate control, not allowing occupants control other than clothing adjustment and spatial migration thus reducing them to more passive recipients of the environmental conditions. The courtyard in contrast, allows the occupants to participate in nature as a larger dynamic system, however this was only a deciding influence on those participants who had experience of natural conditions throughout their lives and were able to appreciate these. Both the spaces were within accepted norms for thermal comfort, leaving other factors as decision drivers. This is especially true for the indoor conditions, which had low thermal variability.

Results from the LL group narratives perspective evidenced cultural influences on clothing adaptation and spatial migration for both spaces. The cohort selecting the courtyard also gave references to rhythmic life through their outdoorsy upbringing as well as the habituation to indoor conditions which closely relate to outdoor conditions. This intensity of exposure to the outside

climate potentially enabled the participants to experience the higher outdoor air velocity and variability of multiple parameters as a source of pleasure. Both cohorts had expectations for the study space to deliver quietness, good lighting and low glare, otherwise the task of studying would have been more difficult. Thus, the task itself predefined some required conditions and as occupants could not adjust the conditions to suit, they had to find a space that already provided the best approximation of their desired conditions, leaving the occupants in a passive role apart from clothing adjustment and spatial migration. Some participants who selected the green alcove were looking for a cooler environment, which may suggest habituation to air-conditioned environments during summer.

With regards to the UL occupant experiences perspective, without exception, all participants were looking for a prospect and refuge spatial situation. In the prospect-refuge theory, these tendencies are thought to be innate and genetic and therefore of a fundamental order in locational decisions. The participants who selected the green alcove referred to rather universal intellectual and perceptual concepts, e.g. how the green wall colour reminded them of nature, how soft furniture texture contributed to the perceived sensation of warmth, or how the complexity of the architectural order provided a source of visual stimulation. More individual contextual concepts were also mentioned, i.e. for both spaces, the spatial order reminded participants of spaces within their individual homes. The green alcove was also selected for prioritization of individual seating ergonomics and for a particular type of (more focused) study. The courtyard was preferred for the air freshness, as the indoor smell was associated with specific unpleasant memories by some participants. Some participants who selected the courtyard indicated an increased awareness of the nature and the desire to experience participation with the nature in that setting.

Conclusion

Key findings are summarized as:

- The objective right-side perspectives of the integral approach revealed shared preferences and behavioural patterns amongst the participant cohort. These were shared either because of common characteristics of the body in all humans or because of the nature of requirements for the task of studying. The subjective left-side perspectives, in contrast, revealed the reasons behind objective patterns and behaviours and they provided explanations for individual deviations from these patterns. While comfort standards tend to focus on shared preferences only, this pilot study suggests that the left-side perspectives may provide new insights into extending the thresholds and limits of standards and dealing with occupant complaints.
- The given study task predefined preferences, in particular, for those parameters that were shared across all participants i.e. for lighting conditions, quietness and the spatial characteristics leading to an experience of a balance of prospect and refuge. If the participants were given a different task, it is likely that different preferences would have been expressed. This suggests that in buildings where a variety of tasks are performed, providing for a diversity of spatial and indoor

environmental conditions could help satisfy larger numbers of occupants.

- All the participants who selected the outdoor courtyard reported a history of exposure to the outside climate at the case study location as well as experiencing home indoor conditions with a much larger diurnal range, as compared to the indoor case study spaces. This indicates that people's past experiences can have significant impact on their behaviour and preferences. Due to the individual variability this often cannot be anticipated in design stages, however it points to the need for diverse rather than uniform indoor environments. Alternatively, if occupant population demographics and cultural background are known during pre-design, then it may also be possible to associate these with appropriate design directions.
- The significance of prospect and refuge as dominant in experiential choices and as a key characteristic of spatial order was an unexpected finding from this study, highlighting the importance of spatial aspects in the evaluation of human inhabitation. For the task of studying and with the given human traffic in the project location, all the participants selected a location which offered a balance of prospect and refuge. For future work, this suggests a greater emphasis with more varied and sophisticated analysis of the spatial aspects as they potentially influence inhabitation experiences and behaviours.
- The preference for the courtyard had its origin in the LL perspective, a background cultural narrative about an outdoor lifestyle, and 'toughing-out' widely variable indoor conditions. The preference for the green alcove, in contrast, had its origin in the UL experiences perspective with individual ideas and interpretations unique to each participant. For both locations the spatial and in/outdoor environmental characteristics were selected to suit the respective narratives.

The results presented here are specific to this case study, however some generalizations can be suggested (Flyvbjerg 2006) and be further investigated. Different spaces and their inhabitants could be investigated and mapped in a similar manner, however the influences of considerations revealed by each of the four methodological perspectives are likely to be different for each space and its inhabitants. The results indicate that it may be useful in future studies to investigate prospect-refuge as a spectrum of conditions and degree of experience applied to multiple space-use nexus situations.

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