Title

How does the built environment affect you? Autistic students' experiences of University lecture theatres and teaching spaces.

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Abstract

Background: Autistic individuals often experience the sensory world differently and it is unclear how this impacts on the learning experiences of autistic university students, specifically. It is plausible that differences in sensory reactivity, such as hyperreactivity (e.g. being overwhelmed by overhead lights), affects autistic students' ability to engage with teaching. Currently, there is little empirical research exploring autistic students' experiences of teaching spaces, in particular in lecture theatres. The aim of this study was to explore autistic university students' lived experiences of teaching spaces and how aspects of these spaces affect them.

Methods: We conducted a qualitative study comprising one-to-one semi-structured interviews with 10 autistic students from three UK universities. Participants were asked about the aspects of teaching spaces that affect them, the effect these aspects have, and the adaptations they would consider helpful. Data were analysed using Reflective Thematic Analysis.

Results: We identified 3 themes: Aspects of Teaching Spaces, Outcomes, and Coping Strategies and Adaptations, each of which contained sub-themes. Aspects of Teaching Spaces included sensory aspects, people, seating, screens, and predictability and control. Outcomes included physical symptoms (e.g. headaches, nausea), mood (e.g. anxiety) and cognition (e.g. attention). Coping and Adaptations included personal coping strategies (e.g. wearing headphones, dressing in layers) and environmental modifications (e.g. have dimmer switches).

Conclusions: This study is the first to establish that the built environment of university teaching spaces affects autistic students' learning experiences. It identifies both personal and environmental modifications and adaptations that could be adopted to support university students' learning experiences. Future research should explore how differently adapted teaching spaces can best influence autistic students' wellbeing to increase positive learning experiences.

Introduction

The built environment around us has an impact on our experiences and can influence our-wellbeing (Song et al., 2020). Autistic individuals perceive the sensory environment differently from non-autistic individuals. In addition to social and communication difficulties, the most recent DSM 5 lists sensory reactivity differences under repetitive behaviours and restricted interests (APA, 2013). This includes being hyperreactive (e.g. being overwhelmed by overhead lights), or hyporeactive (e.g. not noticing if being hot or cold) as well as sensory seeking (e.g. being fascinated with textures) (APA, 2013). It is important to note that autistic individuals have expressed that their sensory reactivity differences can bring them comfort and reassurance (MacLennan et al., 2022), however they can also cause distress and anxiety and have been linked to mental health difficulties (MacLennan, O'Brien & Tavassoli, 2022; Rossow, MacLennan & Tavassoli, 2022).

Several sensory taxonomies have been suggested such as Dunn's, Miller's and He's (He et al., 2023; Little et al., 2018; Metz et al., 2019; Miller et al., 2017). We follow the most recent taxonomy by He et al. (2023) and sensory reactivity differences are described here depending on the level of analysis. Relevant to this study is the level of affective reactivity (how someone feels about the sensory world, e.g. feeling irritated by bright lights in a lecture theatre) and behavioural responsivity (how someone reacts towards sensory stimuli e.g. leaving the lecture theatre when noises are too overwhelming) (He et al., 2023).

Given that sensory reactivity differences are common in autism and are seen in up to 95% of autistic adults (MacLennan et al., 2022) there is growing acknowledgement of the need to design more accessible environments for autistic and neurodivergent individuals (Goldsmiths, n.d.). One of the authors (TT) was involved in design guidance for 'housing for autistic adults' (Brand, n.d.). Recommendations from this housing guidance for the home environment were to consider: environmental triggers; robustness of designs; environments that allow growth and development; and supporting tools. In relation to environmental triggers, sensory sensitivities to colours, noises, textures were identified as important. Designing consistent, low-arousing environments with appropriate lighting, acoustics, and ventilation, with the aim of minimising sensory overload is recommended. Moreover, providing stimulation for residents who seek out sensations, offering private spaces and environments in which stimulation can be calibrated, providing a sense of control and considering the properties of floors.

In addition to Brand's recommendations, there have been other built environment guidance. A frontrunner focussing on the built environment is Dr. Mustafa, who created The Autism ASPECTSS™ Design Index (Mostafa, 2014) as a design guide for environments for autistic people.

It consists of seven principles: acoustics, spatial sequencing, escape space, compartmentalization, transition zones, sensory zoning and safety. The index is based on surveys of around 100 families and their views of the most impacting sensory environment difficulties. Mostafa (2019) also developed a university design guidance, based on online surveys for autistic students and focus groups with academic staff. Some of the findings identified challenges with higher education teaching spaces such as bright lights in lecture halls and noisy projectors. Challenges in other areas included public spaces and transitions, it was reported that signage and navigation was difficult to use and hindered the location of buildings and rooms. Further, a more recent review by Tola et al. (2021) summarises previous work on design guidance, with a focus on sensory hyperreactivity. The three main resulting design recommendations were the following: “sensory quality” (how to reduce the impact of sensory stimuli), “intelligibility” (space being easily understood and clear) and “predictability” (creating an environment that is easy to navigate with visual supports such as signs). Further three categories that relate to recommendations more generally were suggested, “identification of a quiet and accessible location”, “safety and security” and “flexibility and customisation”.

The British Standard Institute (BSI) also came up with design guidance including (*Design for the Mind-Neurodiversity and the Built Environment-Guide Publishing and Copyright Information*, 2022). The BSI PAS covers lighting, acoustics, décor, flooring, layout, wayfinding, familiarity, clarity, safety, thermal comfort, odour, preview of an environment and other sensory design considerations. There is more specific guidance, such as from the NHS for healthcare settings (*“It’s Not Rocket Science” Considering and Meeting the Sensory Needs of Autistic Children and Young People in CAMHS Inpatient Services*, 2020). In this guide, published by the NHS, recommendations are related to making environments more predictable, involving autistic individuals in design decisions, swapping alarms for silent alarms, to reduce noise and the impact of smells and touch and textures. Despite the movement in design recommendations, it is unclear if these are being put into practice (Van der Linden, Dong & Heylighen, 2016).

Furthermore, to our knowledge only limited research has explored the experiences of autistic students in higher education settings. One study found that autistic university students report how environmental aspects, such as volume levels and number of people can mean they are unable to attend social events, increasing feeling of loneliness (Madriaga, 2010). Given that the prevalence of autism is higher than 1% and, in the UK, 2.4% of our university students are autistic, better understanding their learning experiences is a crucial step to improve their higher education experience (Madriaga & Goodley, 2010). To address the need for a better understanding of autistic students learning experiences, we conducted a qualitative study which aimed to explore autistic

students' perceptions and experiences of the built environment of university teaching spaces such as lecture theatres and classrooms.

Methods

The study was approved by the University of Reading Research Ethics Committee (2023-004-TT) and is reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist (Tong et al., 2007). The research team comprised three members all of whom were female: TT who is an experienced autism researcher specialising in sensory reactivity; HM who is a doctoral researcher investigating sensory differences and impact of indoor environment and who has experience in supporting autistic children with high support needs in residential and educational settings; and KH who is does not work in the field of autism but contributed extensive expertise in qualitative methodologies.

Participants

Participants were eligible if they attended a UK university and had either a clinical diagnosis of autism, or had been identified as autistic and were on an NHS waiting list for an autism diagnosis.

Recruitment

All students at a UK university (University A) were emailed with study information explaining that the researchers were interesting in investigating autistic students' perceptions and experiences of the built environment of university teaching spaces. Those who met the eligibility criteria were invited to participate by contacting the researchers. All students who expressed an interest and met the eligibility criteria were included. Snowball sampling was then used, whereby some of those who received the information forwarded it to their contacts at other universities (Universities B and C).

All ten students who expressed an interest participated in the study. Table 1 shows the sample characteristics, highlighting the diversity among participants in relation to the key characteristics of age, sex, autism diagnosis, university attending, and degree stage.

Table 1: Participant Characteristics (*N* = 10)

Participant	Age (years)	Sex (male/female)	Diagnosis (diagnosed/awaiting)	University (A/B/C)	Degree Stage (Foundation/UG1/UG2/UG3/PGT)
1	21	f	diagnosed	A	UG2
2	22	f	diagnosed	A	UG3
3	19	f	diagnosed	A	Foundation
4	24	f	diagnosed	A	UG3
5	26	f	diagnosed	B	UG3
6	20	f	awaiting	A	UG1

7	20	f	awaiting	A	UG3
8	49	f	diagnosed	C	PGT
9	23	m	diagnosed	A	UG2
10	22	m	diagnosed	A	UG2

Procedure

One-to-one semi-structured interviews were conducted via MS Teams by TT; each lasted between 20 and 40 minutes. Online interviews were chosen because they were judged to be more accessible and inclusive for autistic students because they could be in their own environment and could choose whether or not to have the video camera on. A Topic Guide (Supplementary Materials 1) was developed based on relevant research, the researchers' expertise, and previous design guidance. Questions were asked one at a time and participants were advised that they could take a break if they needed to. Auto-produced transcripts were edited for accuracy and anonymised. Information power was used to judge the sufficiency of the sample size (Malterud et al. 2015); given the study aim, the specificity of the sample, the richness of interviews and the analytical approach, it was judged that ten interviews were sufficient to address the research question.

Data Analysis

Data were analysed using Reflective Thematic Analysis (RTA) (Braun & Clarke, 2021); an essentialist/realist epistemological approach was adopted which assumes that participants use language to express their experience and meaning (Potter & Wetherell, 1987). Data analysis followed the six stages of RTA outlined by Braun & Clarke (2021). The analysis was led by TT who met regularly with HM and KH to discuss codes, candidate themes, and alternative interpretations of the data. NVivo was used to facilitate coding (Lumivero, 2023). Initial coding was undertaken by one coder (TT) and followed Braun & Clarke's six steps (C. Braun, 2021; V. Braun & Clarke, 2006)], Candidate themes were discussed in coding meetings (TT, HM & KH) during which themes and sub-themes were reviewed and refined to ensure the thematic structure provided a coherent and credible interpretation of the data that did not only reflect a single researcher's perspective (Braun and Clark, 2022).

Results

Three themes were developed, each with sub-themes: 1) Aspects of Teaching Spaces; 2) Outcomes and 3) Coping Strategies and Adaptations (see Figure 1).

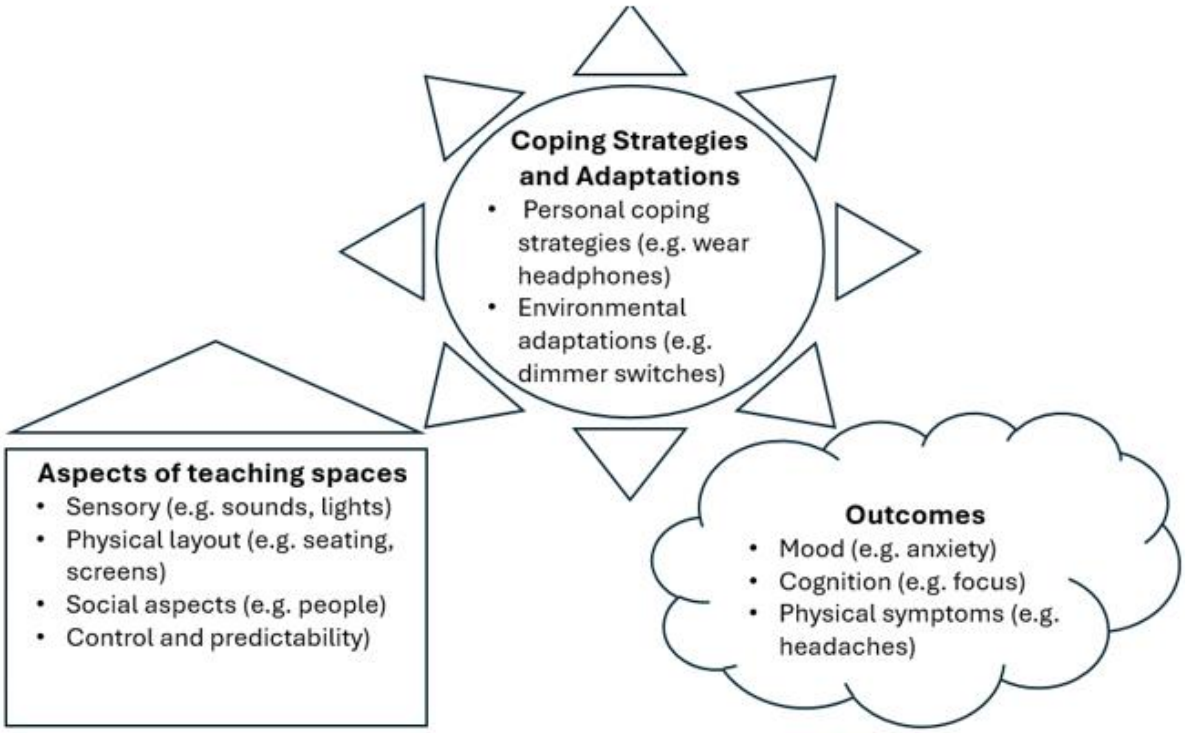

Figure 1: This figure illustrates what aspects of teaching spaces (sensory, physical layout, social aspects, control/predictability) affect autistic students, how they are affected (outcomes), and how they might be supported to cope (coping strategies and adaptations).

Theme 1: Aspects of Teaching Spaces

Sensory Aspects

Sounds

Sounds were described by every participant as distracting, including echoes, sounds made by other people such as tapping, and wall clocks ticking:

> *So I would say that the noise within the room has had an effect on me. Sometimes the echoing that can happen in the hall.... I find myself like being distracted by the sound compared to like what is said. So like I'm too busy focused on the sound of it instead of focusing on what is being said by the lecturer. [P1]*

> *But like you know, sometimes I have clocks on the walls and you can hear the ticking. So I don't know like that because it's just like not everyone can hear it, but I can hear it and it's just like, very distracting and repetitive and yeah.(P2)*

Lighting

Most participants also described the lighting negatively:

> *I think sometimes like the lights like they're quite bright. (P02)*

> *And then the light… there's a glare on the screen. (P03)*

Temperature

Temperature was mentioned by several participants, mostly in relation to the room being too warm:

> *So yeah, that's temperature as well, so normally I get too hot in lecture theatres because I'm very overly sensitive to overheating. (P05)*

> *And definitely temperature 100%. Usually on the most high temperature. So if if the room is too warm... in winter. So if it's, if it's like a fake heat..(P03)*

Touch and Texture

Touch and texture were mentioned by participants, but the experience varied. Seats were described by some as too soft :

> *We usually have hard seats, whereas sometimes in lectures they have weird soft seats and that can be quite itchy and just not very comfortable. (P03)*

Proprioception

Proprioceptive issues were mentioned, such as clumsiness affecting the experience of walking up and down aisles:

> *I think it's because that the stairs are always weirdly shallow, so my feet aren't as this is gonna sound silly, but my feet aren't as used to walking down incredibly shallow steps, so I'm always worried. I'm gonna like, trip.(P05)*

> *So, like I tend to be very clumsy and like drop things a lot and I think when again when I'm in an area with tight space and…, it can be quite difficult because it creates again I don't like it. So it's like I think fine motor skills. I end up just dropping stuff and it gets very frustrating. (P07)*

Smell

Odours, for example caused by bins or others in the room, were described by participants as noticeable and aversive:

> *But look, if people are stuck in a room for several hours at a time, it's gonna get a smell. So if it gets like hot and stuffy as well.P05*

Physical Aspects

Space

Participants described space in and outside of the lecture theatre as of crucial importance, affecting their mood and wellbeing:

> *Because that be very overwhelming and there's a lot of chitchat beforehand and the space outside the lecture theatres tends to be quite small and cramped, and everyone's kind of huddling.(P09)*

> *I do like to have a lot of space because you can feel kind of irritated when you're waiting for a break and there's not a lot of foot space in the lecture theatre, I feel. I think that's one thing I didn't really like. (P01)*

Seating

Seating was mentioned as a problem when space is restricted:

> *I guess I would like to start would like the idea of the seating and sometimes if it's very compact that could be, you know more and more like the one row in front of the other. That could be quite claustrophobic in a way. And feels like everything's touching. (P03)*

> *It's very picky, but I don't like lecture theatres where the rows so you have to shuffle along a whole row.(P05)*

Screens

The number of screens in the lecture theatre were often mentioned, mostly highlighting that the number of screens and their locations can be distracting:

> *I think this too many screens like I think I don't think it needs that many screens to be honest. So maybe if there was less screens, it would be better as well because it's like I*

have my laptop, I have the lecture on my laptop and then I see the same slide on like probably like six other screens (P01)

You've got screens on both sides, right? So usually they'll be some sort of slides. If you set anywhere in the middle, you're kind of like looking diagonally. Then if you sit on the right, the teacher won't be standing on the right, but you'll be able to stare at the screen, stand on the left. You're making direct eye contact with the teacher.(P9)

Social Aspects

People

Participants described other students as a cause of distraction and distress for a range of reasons:

Like 'cos a lecture hall has a lot of other people. So there's so many other things to look at, to be distracted by. I wanna space myself out from my friends, cause it's kind of like rude and stuff, but I will have to sit next to them and the seats are quite close, so I guess, but I don't really like to be too close to people. (P01)

...like with like noise and stuff like I think, I mean it's not really something about the actual lecture theatre. Just like, you know, other people are talking over like the lecture like other people have their own conversation. I can find that a bit like distracting, annoying sometimes, but it's not really anything to do with the actual, like, theatre itself. (P02)

I do not like that, so I'm very aware of, like other people coughing or just shifting in their seats or talking. (P05)

Control and Predictability

Participants reported that it was easier to deal with environmental factors if they were within their control and more difficult if they were outside of their control or unpredictable.

And in terms of the spacing and feeling crowded, I can try and mitigate that by going at the front or at the edge or just avoiding other people, whereas the big ones like the lights and the noise and the temperature and the ventilation, you can't really do anything about.(P05)

But I always liked it when there was kind of like a consistency in terms of rooms. So I'm not sure how related to stability, but I think there's like, so that's quite a relevant because I kind

of always associated to an extent, a lecture a certain seminar. We've got a room, so when it kind of like....So when I had like a lecture where they would like to change the room every week... It felt like I was always going into unfamiliar territory...This is annoying as well, but when like one week I'm bringing round and taking into a building we've never been before. And then it can kind of become like more of warning because it's like I'm suddenly going somewhere, which is, like, completely unfamiliar....P07

I feel like the softness (of the seats) is getting on to me and there might there might be like crumbs or sensations that I can't see or control. So it kind of increases my feeling of uncertainty. And whereas if it's something hard, I can easily feel my body sitting and yeah, I just feel like I have more control over my body in the space. And how that impacts my learning. Well, I guess I would be less I'll be more attentive to the lecturer and broader than like how I I might feel more like uncertain and anxious, yeah.P09

Theme 2: Outcomes

Mood

Participants described the impact the built environment can have on their mood as well as a bi-directional relationship between sensory effects of the environment and mood, for example with sounds in the environment overwhelming them but their mood also impacting their sensitivity to sound.

It makes feel like tense. Like, feel very tense.(P2)

I think the echoing it can be a bit much sometimes, but mostly when I'm anxious... Like I said, whenever I'm feeling anxious, I feel like it's this effect is enhanced.(P1)

Physical Symptoms

Respondents described the environment as impacting their physical state, for example dizziness, nausea, headache and appetite loss and, in an extreme case, vomiting:

So I think, yes, sometimes they're too bright and it could, like, give me headaches and stuff. (P02)

It could also impact sometimes like my desire or like want to eat food as well.(P5)

I feel just really uncomfortable and not able to eat lunch if it's like directly afterwards. (P3)

Cognition

The environment also affected participants cognitive functioning, including the ability to focus, pay attention and concentrate.:

And just be distracted and like, I don't know, just be a bit overwhelming, I guess.(P2)

It can also just make me feel uncomfortable in my body anyway, which again just effects my concentration.(P3)

I would say effects like how quickly I'm able to process the information that's being given to me. Usually it just slows it down and I won't really know What's going on? I'll kind of zone out, dissociate in a way until after the lecture.(P10)

Theme 3: Coping Strategies and Adaptations

Coping Strategies

Participants described adopting various personal coping strategies to deal the environment:

So like if it was too like if it was too loud or whatever I just put my music on and then just do the noise by myself like I think that's kind of yeah I'm trying to think well I've got noise cancelling like ear plugs... if it is really annoying me, I'll just put my music on or something. I mean, it's just like that, just like I don't know, an adaptation I made for myself kind of thing. (P2)

I've had to had have worn sunglasses in lectures before. I always take some with me because sometimes it can be too bright.(P10)

They also described used timing as a coping strategy, arriving either early or slightly late to avoid crowds of people entering at the same time. Some participants found the only effective coping approach was to leave the lecture theatre for a break.

And yeah, I usually arrive kind of later so that I'm not in that busy space. And then I tend to not be like sensory overloaded, (if there) not too long before the lecture begins. (P1)

I had (to leave) the two or three times… because my head just felt so full.(P1)

Adaptations

Participants suggested aspects of the environment that could be adapted to make it more enabling. Relating to the Sensory Aspects theme, where artificial heat and clinical lights were described negatively, the introduction of natural features were described positively, for example natural ventilation and natural light. Similarly, in relation to the Physical Aspects theme, participants suggested having control over settings, such as having dimmer switches. Another suggestion was allowing early entry to lectures.

> *Any sort of natural ventilation I think would be more would be beneficial. I would say natural ventilation in some sort of way and maybe just access to like water. You can get those tap things that you take water from. Maybe just have one of those in the lecture theatre to help regulate temperature.(P3)*

> *Umm, I would probably say also you kind of spaced out rooms and multiple screens like those are two things I'd say helps out a lot. And personally, like my kind of idea with ideal one would be kind of a large like spread out area where there's places to sit whether it's like kind of quiet space (P7)*

Discussion

Autistic students were asked directly about their experiences of the built environment teaching spaces in higher educational settings and described Aspects of Teaching Spaces; Outcomes; and Coping Strategies and Adaptations. While some of these themes align with previous design guidance and recommendations (Mostafa, 2014, 2019) others are specific to the learning environment of university classrooms and teaching spaces, namely lecture theatre seating arrangements and the amount of screens in a classroom.

In relation to aspects of teaching spaces, several sensory aspects of lecture theatres were reported by autistic students in this study as distracting and overwhelming, such as bright lights, echoey rooms, smells, textures of seats. As identified in the ‘housing design for autistic adults’ booklet co-developed by on of the authors (TT), sensory triggers were mentioned, such as colours, textures and smells (Brand, n.d.). As Mustafa pointed out in her ASPECTs guidance, designers should consider acoustics as well (Mostafa, 2014). Here the examples provided by autistic students were more specific to lecture theatres that you experience when attending classes at a University. For

example, the glare that some tables or screens have, the amount of screens in a classroom, the sound of typing when other students are taking notes. Notably, participants described the importance of control and predictability, noting that teaching spaces did not create difficulties for them when they were able to have some. This is in line with both Tola (2021) and MacLennan's findings highlighting the importance of creating predictable environments. Given that lecture theatres are shared spaces, control over lighting or volume poses challenges but participants' comments indicate that a lack of control may be ameliorated if the room does not change over time. This indicates that consistency in room allocation and enabling students to become familiar with the room before the lecture starts could be supportive. This would further allow autistic students as well as non-autistic students to identify what support or adaptations may be needed within a given classroom, e.g. dressing in layers for rooms that are on the warmer side.

In their recent study investigating autistic adults' sensory experiences, MacLennan et al. (2022) found outcomes could be categorised as short term (e.g. overwhelm) and long-term (e.g. mental and physical health challenges) (MacLennan et al., 2022). In this study participants reported outcomes that were short term, for example that the environment of the lecture theatre influenced their mood (e.g. being irritated) and cognition (e.g. not being able to concentrate, zoning out) and also produced physical outcomes such as feeling nausea and headaches. While these outcomes were shorter lived compared to long term outcomes such as mental health challenges, some autistic students said the rest of their day could negatively impacted by spending time in a sensory unfriendly environment. University life was also compared to school life where it was more difficult as there were fewer breaks and less independence. Thus, for some autistic students having the chance to leave the lecture theatre when required seems beneficial and should be incorporated into learning practices. Increasing awareness among teaching staff of how sensory aspects of the environment can affect autistic students could improve autistic students learning experiences.

A novel aspect to this study was that autistic students' coping strategies were explored. Students described using personal coping strategies, such as adjusting their clothes, using headphones and timing their attendance. Based on this, one recommendation for better supporting autistic students may be for sensory toolkits to be made available in teaching spaces so that students could borrow sensory equipment if required.

Aligning with Tola et al's (2021) suggestion for 'flexibility and customisation' (Tola et al., 2021). environmental adaptations based on participants' experiences may also be possible to adopt in current teaching spaces, for example dimmer switches, and adjustable artificial heat. Some of the arising issues described by participants related to teaching spaces being shared environments, and some autistic students mentioned the advantages of being able to listen to recordings in their own

home where they can control the amount of light, heat and noise better then in a shared lecture theatre. Recording lectures thus could be a beneficial as autistic students could review recordings once in their own environments. Many adaptations suggested by autistic students could potentially be beneficial for non-autistic students as well and should not hinder learning for anyone. A lecture theatre that is too hot can affect everyone's learning, thus recommendations could be effective more broadly. Future studies should explore the impact of teaching spaces on non-autistic students.

In conclusion, this study describes autistic students' experiences of the lecture theatre environment at University. Its findings should be used to guide those who design university teaching spaces as well as university teachers. Furthermore, future experimental work should involve experimentally manipulating the environment (e.g. changing brightness of the room) to see if it can improve autistic students learning so that in future teaching spaces can be improved and made flexible to support different learners within a higher education environment.

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Topic Guide

2)

o What aspects of the built environment (examples) have an impact on you in a lecture theatre and/or seminar rooms?

o In what ways do the built environment impact upon you? i.e How do you know the environment is impacting on you?

o What makes you believe/how do you know the environment impacts on you?

o What aspects of built environment help you?

o What would you change about the built environment of lecture theatres to make it more suitable for you? - what adaptions do you already have in place?