UN-IMPAIRED STUDY

A STUDY ON INCLUSIVE STUDY SPACES

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Acknowledge-ments

NEURODIVERGENT*

*Neurodivergent can be defined as a person whose neuro-cognitive functioning diverges significantly from the dominant societal standards of "normal".

"Neurodivergence (the state of being neurodivergent) can be largely or entirely genetic and innate, or it can be largely or entirely produced by brain-altering experience, or some combination of the two (autism and dyslexia are examples of innate forms of neurodivergence, while alterations in brain functioning caused by such things as trauma, long-term meditation practice, or heavy usage of psychedelic drugs are examples of forms of neurodivergence produced through experience)." (Walker, 2020)

ABSTRACT

At the TU Delft, 9% of the students officially have an impairment, however, estimates go up to 30% (Centrum Hoger Onderwijs Informatie, 2019). The TU Delft is building new spaces to accommodate its students but seems to do so for the median student. Little research has been conducted into the environmental needs of students in higher education with a neurological impairment which is why this thesis aims to answer the question: "In what way can the needs and wishes of neurodiverse students be combined with the needs and wishes of neurotypical students to create an inclusive study facility for the TU Delft?". Six students, both neurotypical and neurodiverse, were interviewed online in a semi-structured interview. From this, it became clear that the neurodiverse students have more needs than the neurotypical students but it should be possible to combine most needs and wishes in the same building.

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INTRODUCTION

There is a trend visible in the number of diagnoses of Autism Spectrum Disorder (New York Times, 2002) and Attention Deficit Disorder (Visser, et al., 2014).

Officially, 9% of students at the TU Delft are registered as students with a disability (TU Delft, 2020a). However, ECIO (Expertisecentrum Inclusief Onderwijs) estimates that 30% of students in universities have an impairment and 10% of total students are impacted in their studies by this impairment (Centrum Hoger Onderwijs Informatie, 2019). In 2018, the TU Delft had 24.703 students (TU Delft, 2019), leaving 2.470 students whose studies are impacted by their impairment.

The TU Delft has committed to the Declaration of intent UN Convention higher education institutions where they declare that they:

• Wish to be inclusive educational institutions, where every student participates in the education on an equal basis with other students and every student feels welcome and accepted irrespective of background.
• To this end will carry out activities in the field of education for the implementation of general accessibility.
• To this end will connect objectives and activities in the field of education that link up with the joint approach of the State and administrative partners for the implementation of the Convention.
• To this end will cooperate with each other to share knowledge and

develop policy by which inclusion in education is enhanced and strengthened.

To this end they have formulated a policy document describing how they (plan to) address, assess and improve their policies regarding students with impairments (TU Delft, 2020a). However, the document is lacking in one area: the physical study facilities at the TU Delft. As Winston Churchill famously stated: "We shape our buildings, thereafter they shape us". The physical environment one studies in has great effect on oneself.

The TU Delft is renewing the campus and wants to invest in world-class facilities (TU Delft, sd). In 2018, the new educational building Pulse was completed. It has 1.020 education spaces and approximately 160 self-study spaces (TU Delft, 2020b). At the end of 2019 the TU Delft started building another new educational building: Echo (TU Delft, 2020c). The TU Delft is building extra study facilities for their neurotypical students, but it is missing an opportunity to build a futureproof, inclusive building for self-study for all its students.

Therefore, the main research question of this paper is:

"In what way can the needs and wishes of neurodiverse students be combined with the needs and wishes of neurotypical students to create an inclusive study facility for the TU Delft?"

I will try to answer this question by first researching the needs and wishes of the neurotypical students and the needs and wishes from the neurodiverse students. These will be compared to see where the needs and wishes are of no influence on each other, match or contradict one another. From this, it will become visible what to implement in the design and what to avoid. The sub-questions of this paper are therefore:

"What are the needs and wishes of neurotypical students regarding a study facility?"
"What are the needs and wishes of neurodiverse students regarding a study facility?"
"How do these results compare?"
"What should be implemented and what should be avoided?"

I will start by explaining the method after which the results will be discussed. Then a discussion is provided before concluding the paper.

M ETHOD

The objective of the research was to gain insight into the needs and wishes of neurotypical and neurodiverse students at the TU Delft regarding their study surroundings. To achieve this, a group of six students were interviewed online. Three of these students are neurotypical and three students are neurodiverse.

To gain qualitative information regarding the architectural surroundings, the domains as named by Elise van Dooren in *Making explicit in design education: generic elements in the design process* (2013) were used. These five domains are:
· space/form/image/composition
· material/structure/climate
· function/route/use/ritual/movement
· site/urban context
· context/social/historical/cultural/philosophical

However, to merely question the interviewees on these domains would not provide insight into what they deem most important for a space. Therefore, a semi-structured approach was chosen. In doing so, the interviewees had the opportunity to express their opinions without being halted by a rigid question sequence.

To collect both do's and don'ts regarding the study design of the studyspace, the interviewees were asked about their favourite and least favourite place to study at the TU Delft. The interviewees were first asked what their favourite place to study is on the TU Delft campus and why. This allowed them to speak freely and

recollect the spaces' respective spacial highlights. Next, they were asked a number of questions regarding the aforementioned domains. Lastly they were questioned about what could be altered or added to the space to improve it even more. This provided both quantative and qualitative results. This process was repeated for their least favourite study space on the TU Delft campus. To assess for possible missed input, the same process was also repeated for any study space outside of the TU Delft campus.

Interestingly, during the interviews it was found that almost all students interviewed had an outspoken opinion regarding the study facility Pulse at the TU Delft. Therefore they were also questioned on this opinion which provided insight in both positive and negative architectural attributes of the building and its impact on the ability to study.

The interviews were conducted in Dutch and all quotes used in this thesis have been translated with due dilligence to protect and capture the nuance of the original statements. The complete set-up of the interviews can be found (in Dutch) in the appendix.

A discription of each student can be found on the next pages. The names and images of the students were changed to assure their anonimity.

Due to the Covid-19 pandemic, the method used in this research was impacted. The initial method was to interview students at their preferred and disliked study space at the TU Delft. This would have put the students into the space, creating the optimal environment to comment on it. However, due to the lockdown in the Netherlands, this was no longer possible. Instead, online interviews were conducted. An unexpected bonus to this could be that the interviewees had to recollect what affects them most, assuming that what was top of mind is most pertinent, creating a hierarchy in their comments.

Rachel
Female, 22

Current study
BSc Applied Physics

Neurodiverse
Processing Speed Limitation

Steven
Male, 20

Current study
BSc Applied Physics

Neurotypical

Mark
Male, 27

Current study
MSc Computer Sciences and MSc Science
Education and Communication

Neurodiverse
Autism Spectrum Disorder, ADHD
and highly gifted
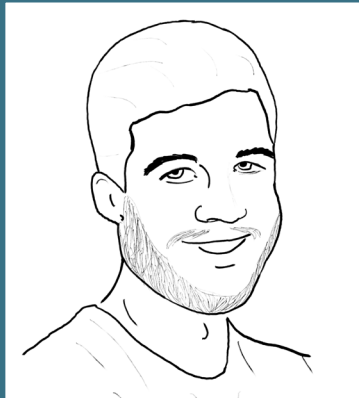
Jort
Male, 21

Current study
MSc Mechanical Engineering
Track: Multi-Machine Engineering
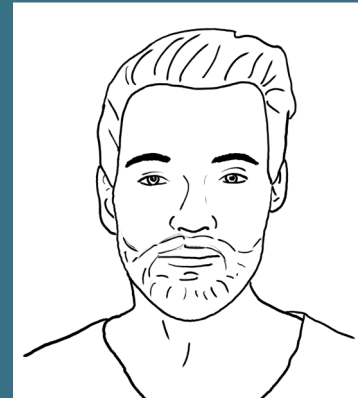
Neurotypical

Emma
Female, 25

Current study
MSc Architecture, Urbanism and Building
Sciences
Track: Urbanism

Neurodiverse
Autism Spectrum Disorder

Tugba
Female, 26

Current study
MSc Strategic Product Design

Neurotypical

RESULTS

In this section I will provide results from the interviews for each interviewee. The results will be made visible by way of quotes and a sketch of a space befitting the charactaristics named.

These results will be compared and explained, after which a more practical view through three scales will be provided. This will combine available literature with the results from the interviews to form a comprehensive understanding of what to implement and what to avoid when designing an inclusive study environment for higher education.

Rachel
Female, 22

Current study
BSc Applied Physics

Non-neurotypical
Processing Speed Limitation

"It takes me longer to understand assignments. Usually I will ask someone to explain it again in the exact same way. After that I will probably understand it."

The limitation Rachel has, means that it takes her longer to comprehend what's being explained. Therefore she needs to study longer than her peers.

For Rachel, what makes the perfect study space are size, control, occupancy and subsequently, location: far from the heart of the campus.

"To the left there you can get distracted by people walking by, I quite like that myself, just a bit of movement. You can see the door [...] that's quite nice."

"... there are also those computer halls with quite a lot of people and they sit across from you so that when you look up, you stare straight into their face, I find that less pleasant."

"The light and the quiet [are what make it a nice place to study]. That it's a small space. If you're in a large space like that there are more people there, so more is happening. I always like it when there are people, so all by myself is not nice, also because there is no necessity to do something when no one is watching, but those spaces are really... enough people fit inside that can watch you study."

"Where everybody comes to study, I study best."

"It's in the middle of nowhere, you have to travel the world to get there, that is quite nice."
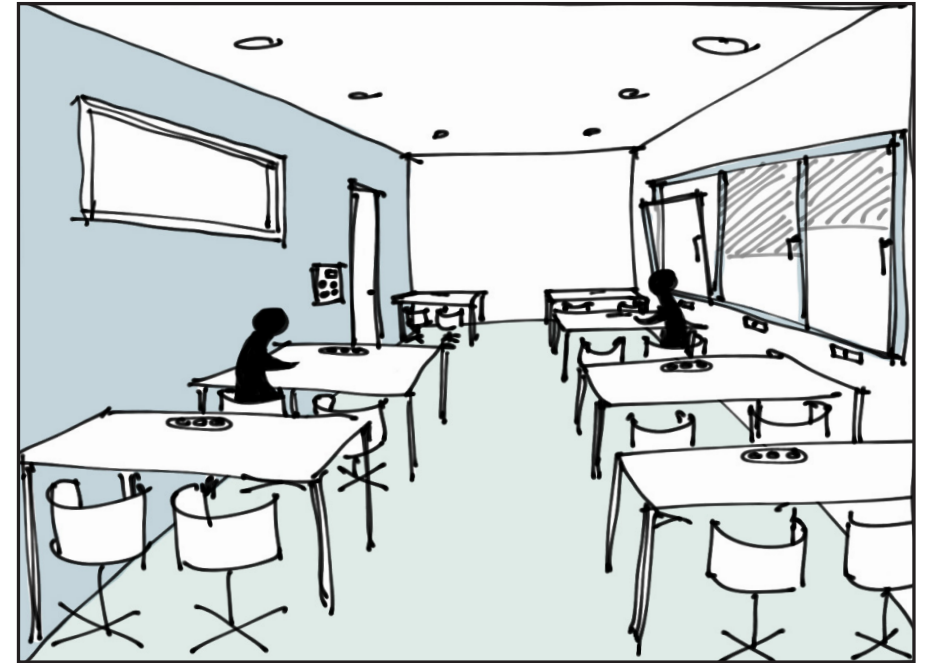
Figure 1: a sketch of Rachel's Ideal Study Space.
This space provides a good overview due to its small width. There are windows that can be opened or closed by occupants and window screens that can be lowered as well. The panel by the door manages the lighting, heating and ventilation. This is all accessible. Additionally, every desk has access to power outlets. The space is adjacent, but not too visibly connected to the hallway and is located far from the heart of the campus, making sure not too many students flood it.

SPACE/FORM	MATERIAL/STRUC-TURE/CLIMATE	FUNCTION/ROUTE	SITE	CONTEXT
Small spaces Narrow spaces	**Light** Large windows with sunscreens Light colours	Not in the walking path **Enough poweroutlets** View of the door Close to amenities No multi-use building	**Far away from the campus centre** Not too busy outside	**Tranquil** **A small number of people who are studying** Control over the space Not too quiet Small amount of movement outside
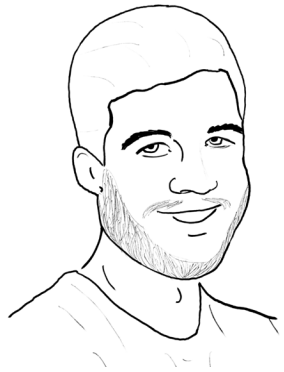
Mark
Male, 27

Current study
MSc Computer Sciences and MSc Science Education and Communication

Neurodiverse
Autism Spectrum Disorder, ADHD and highly gifted

"My mind is quite chaotic, I'm easily distracted. If I get a whatsapp message, I can lose my studyvibe for 20 minutes."

Mark is on the Autism Spectrum, has Attention Deficit Disorder and is highly gifted. This means that although he is very bright, he is easily distracted.

"At the top floor of the old Technical Science building, there's a computerhall, kind of hidden. There are several small rooms. Someone moved a table into the corner so that your back is against the wall and your side is against the window while you have a good overview of the space. That space is just fantastic. Except when there's a bunch of first year students, then not so much."

"The glass hall in the University Library is bad, but the tower is impossible: it's always busy, it's super noisy, people walk behind you constantly and the floor sways. I avoid the tower like the plague..."

"When I study, I surround myself with people who are also seriously studying. That creates a study atmosphere. If you have to brainstorm or have to talk to someone, you walk away to a different space."

Overview and the people around him are important factors in Marks ideal studyspace as well as limiting distractions.
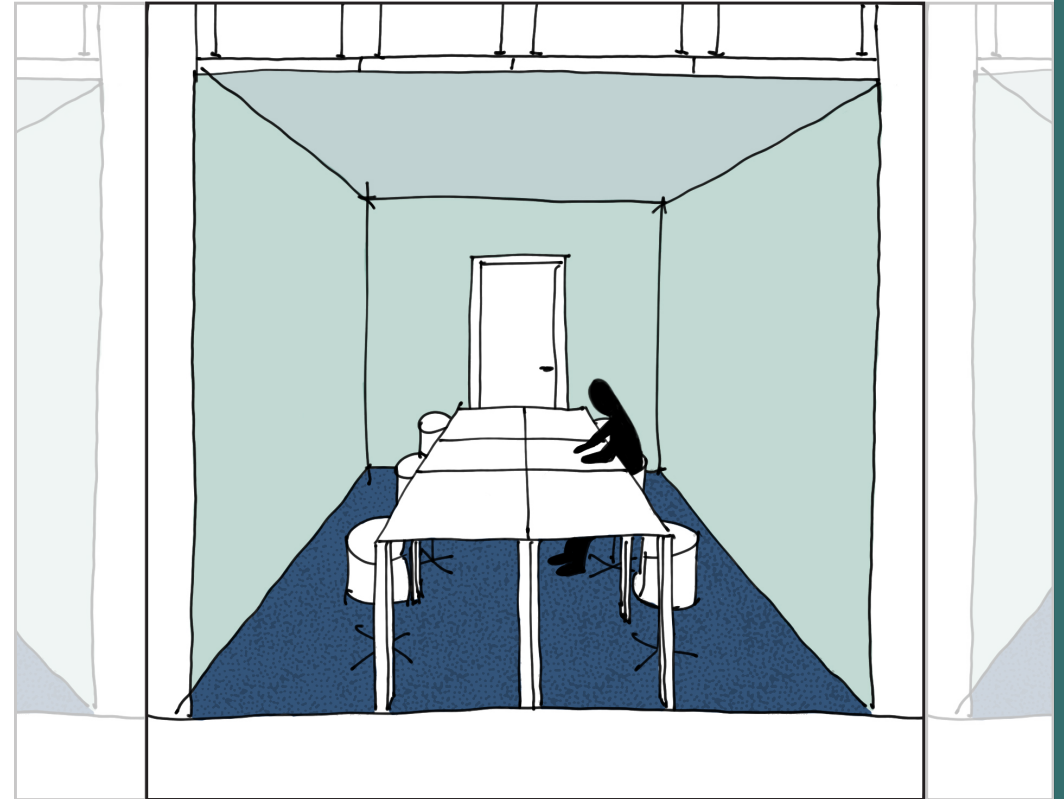
Figure 2: a sketch of Mark's Ideal Study Space.
The space is small and can be imagined in a row of similar spaces to form cubicles for group work. The construction is sturdy and well isolated. This space does not have any other attributes, making it specifically suitable for studying, filling only with serious people. Due to its small nature there is an adequate overview.

SPACE/FORM	MATERIAL/STRUC-TURE/CLIMATE	FUNCTION/ROUTE	SITE	CONTEXT
Small spaces Cubicles for group work	Good construction Not too noisy	**Just for studying**	-	**Overview** Not too busy Not too loud Tranquil study-space Serious people

Emma
Female, 25

Current study
MSc Architecture, Urbanism and
Building Sciences
                Track: Urbanism

Neurodiverse
Autism Spectrum Disorder

"I suffer from impulses; in a lecturehall where everybody moves, or with sounds around me. Smells can also impact me greatly. [...] If people come in late to a lecture, my focus shifts."

For Emma, impulse control is a very vital step in studying. She also states she misses an impulse-low studyspace:

"Yes, I miss acoustic dampening in studyspaces. Also in lecturehalls now I think of it."

"For studying, I use the library of the Architecture faculty. It's nice and quiet. [...] I like that there is carpet, it dampens the sound of walking people. A less pleasant element is that the floor is a kind of mezzanine floor which moves when people walk on it."

"I like it when there is not a lot of white or harsh colours in spaces. [...] In general, dark is nice for me. A light, non-bright colour is also nice for me."

"[The faculty of] Architecture is slightly outside of the campus, [...] with greenery on every side. That is very nice."

"I like being able to control the amount of light myself."

Lastly, Emma comments that control over an impulse (light) is pleasant.

Figure 3: a sketch of Emma's Ideal Study Space.
This space provides a large view of the outdoors while creating a tranquil environment inside. The floors are carpeted to ensure silent footsteps and the colours are calm. Aside from the abundance of natural light, private desklamps create control over one's lighting situation. Due to the layout of the room, this is a destination in stead of a space for walking about.

SPACE/FORM	MATERIAL/STRUC-TURE/CLIMATE	FUNCTION/ROUTE	SITE	CONTEXT
Large glass wall for looking outside	**Well lit** **Warm light** Natural light **Carpeted floors** **Good construction** **Calm colours**	**Not in the walking path** No food smells	At ones own faculty feels familiar Green surroundings	**Tranquil** Social control Control over the light

Steven
Male, 20

Current study
BSc Applied Physics

Neurotypical

"[The nicest place to study is] Drebbelweg. There, the least amount of people sur-round me and there are not a lot of people anyway. [...] So it is nice and tranquil.'

"It looks large, but it feels small because there are a lot of smaller areas. There are white walls surrounding you, so you don't really see that much. [...] A wall with a different colour would make the space more warm and lively."

"There is enough daylight. On one side there are large windows that bring in a lot of light."

"The focus in this studyspace lies more with studying than in other studyspaces. It's more calm, you see less people. Because of this, you get the feeling that focus is good. It's relatively quiet."

Tranquility and calmness seem to be key in Steven's ideal studyspace. This is illus-trated further when he reacts to his least favourite study spaces.

"[My least favourite studyspace is} The second floor of Civil Engineering. [...] When you look to your left or right, you always see someone moving. Theres is sound there, but I can shut myself off from that fine. The movement is more annoying."

"[In Pulse,] I actually never know where I will end up. If I walk into the elevator and press the button for the highest floor, I still wonder where I will end up. The same happens when I walk up three flights of stairs, I never know where I will end up. And I have been to Pulse really often. [...] It's a giant maze really, seems fun at first but is actually quite sad."
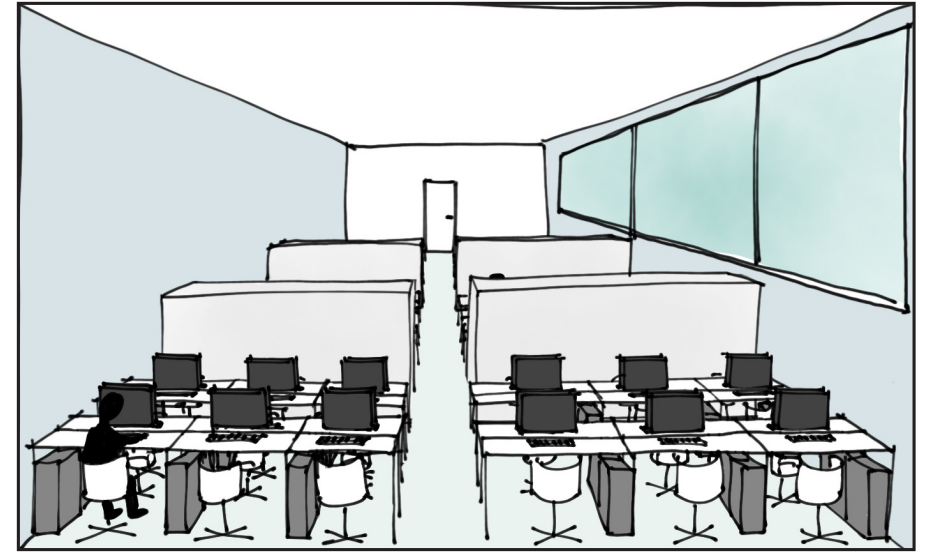
Figure 4: a sketch of Steven's Ideal Study Space.
Steven prefers a large space that is subdivided in some way. The cabinets facilitate that in this example. The large windows provide a lot of light and the calm colours keep it from overbearing. To the sides, there are study "havens" where no one walks past. For the space as a whole, the occupancy level is quite low, but since it is a large space, there are enough other students present to facilitate a study atmosp-here.

SPACE/FORM	MATERIAL/STRUC-TURE/CLIMATE	FUNCTION/ROUTE	SITE	CONTEXT
Big sectioned space	Light No dark colours Not just white	Not in the wal-king path Clear route PC screens	-	Tranquil Study atmosp-here A few people

Jort
Male, 21

Current study
MSc Mechanical Engineering
Track: Multi-Machine Engineering

Neurotypical

"The space is high, has enough light, due to the skylights and the tables are big. Bigger than at Pulse. The chairs are adjustable in height."

"The walls are just white. One wall is red on the inside and the outside."

Jort likes the silent studyspace at the faculty of 3mE. He however very much dislikes the study platforms at this faculty.

"3mE has hanging platforms with desks and chairs. They are a kind of balconies, I really dislike that. The atmosphere is never nice, the screens to shield your desk off I don't like. Additionally, the only way to get to your desk is to walk behind people, I don't like that either. When someone walks somewhere, the entire balcony vibrates. I think this is annoying and unneccesary."

"I believe a different kind of person studies there. People who are more at ease with sitting by themselves. People who don't like to study in groups. I believe that's a different kind of person than in the silent studyspace. In the silent studyspace there is a better overview, on the balcony you are seated with your back turned towards other people."

"The view, however, is great. What stands out most of all is the water with the row of trees. In February and March, it stands out. Defenitely a beautiful place."

Figure 5: a sketch of Jort's Ideal Study Space.
Jort specifically described a larger space, sectioned by ceilingheight. Due to the large windows, this space is light and there is a view of water and trees. The space is coloured by red accents. The desks are large and amenities like a printer are closeby. The people studying here are quiet and seriously at their work.

SPACE/FORM	MATERIAL/STRUC-TURE/CLIMATE	FUNCTION/ROUTE	SITE	CONTEXT
Big sectioned space **High ceilings (and variation in height)** Overview of the space	**Light** **Well constructed** **Not too warm** Plants are nice Low ceilings more light Red accents	**Not in the walking path** **Large desks** **Adjustable seating** **Printers close by** Power outlets Nice space for breaks	**Central location** **View of water and trees** View of cyclists from afar	**Quiet** Serious people

Tugba
Female, 26

Current study
MSc Strategic Product Design

Neurotypical

"When you're doing practical work, [the main hall in Industrial Design] is a nice space. [...] It's an open space, then you will not be bothered by others. Especially when a lot of people are working on the same thing, you get the feeling you're working together towards one goal."

"There's always something happening at Industrial Design. You find yourself in the midst of hardworking people, insipiring expositions and educational activities. There's a nice balance between stressed-out people who are working towards a deadline and people who are chilling out."

"It's a beautiful space, but because I have been working at Industrial Design for so long, I'm starting to think the colour blue is getting too blue. Sometimes I look around and think "Wow, just stop being blue". [...] White is a nice colour. Because of a white table I can focus my attention better at my work."

"There are a lot of different seating options: you've got low chairs, high barstools and a variety of couches. Usually I go to the studentassociation, they have these dank sagging sofas which I secretly like."

For Tugba, white is the blank slate on which creation can happen. This is important as well as the ability to be oneself:

"The atmosphere is inspiring [...]. Alongside Architecture, Industrial Design is a bit more practical than other faculties at the TU Delft. Because of this it is easier to lug around a sick prototype made from three cardboard boxes without people looking at you as if you are weird. You can be yourself at ID (Industrial Design)."
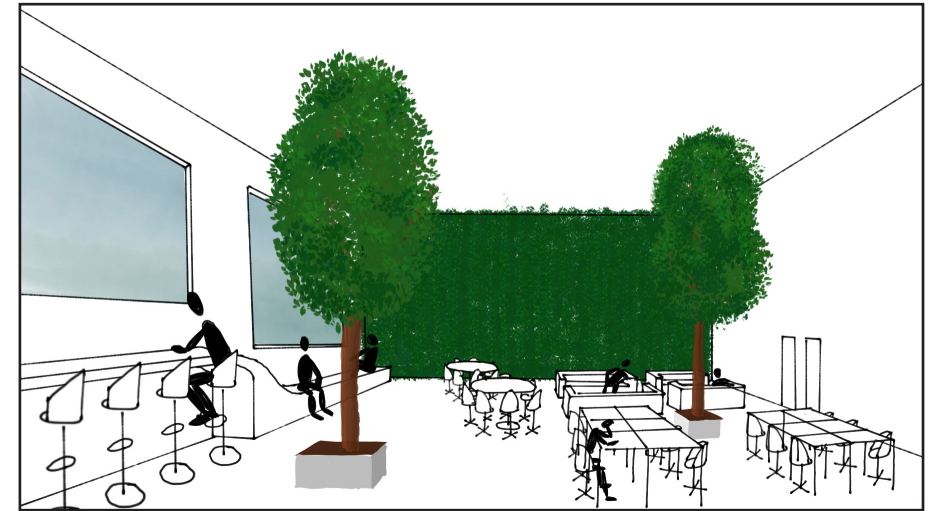
Figure 6: a sketch of Tugba's Ideal Study Space.
This sketch illustrates a white space with a lot of greenery and a variety of seating areas and studyplaces. The large windows facilitate daylight while the space is open and wide.

SPACE/FORM	MATERIAL/STRUC-TURE/CLIMATE	FUNCTION/ROUTE	SITE	CONTEXT
Open space Lots of space Not too high ceilings	**Light** Plants Variety White White desks focusses View of the street Large windows	**Coffee close by** Lots of different seating areas	Central location	**People that do the same** People with their own expertise nearby Inspiring Not too quiet People who (seem to be) studying

The results of all the neurodiverse and neurotypical students can be found in figure 7 on pages 34 and 35. In white, the absolute clashes are made visible. While a lot of results are different, only two cannot work together in the same building. Firstly, most students indicate they would like light and calm colours, which doesn't fare well with pops of bright red. Lastly, the building cannot be at everyones respective faculties, in a central location and far away from the campus centre at the same time.

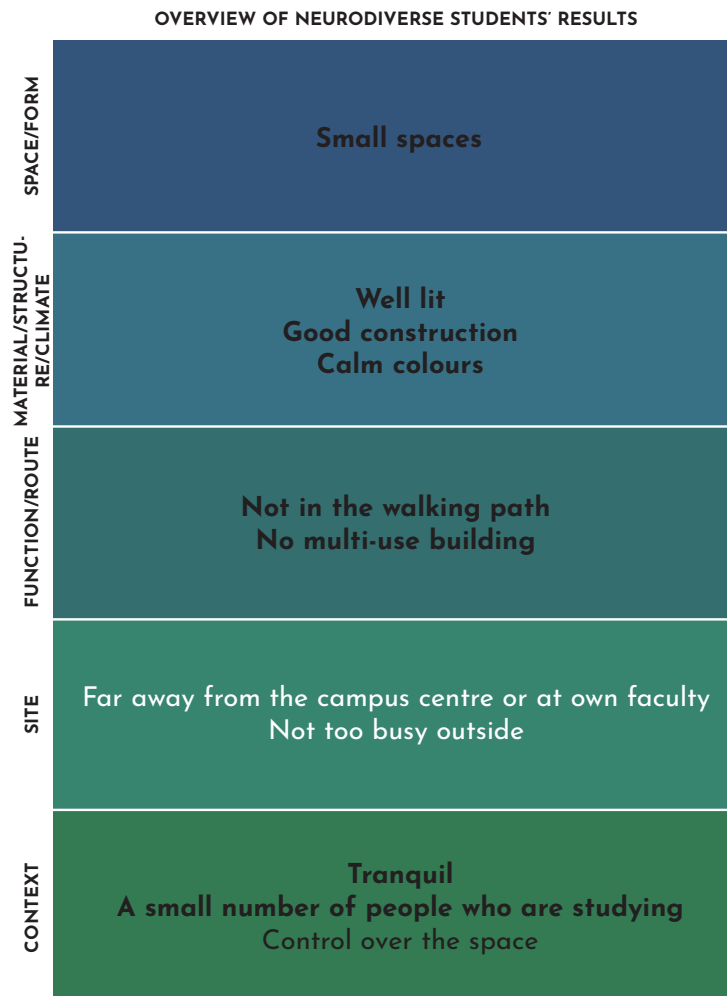Figures 8a and 8b show an overview of the most important results for respectively the neurodiverse and neurotypical students where only in the domain "site" a clash is visible. The domain "space/form" could look like a clash at first, but even though a room cannot be both big and small at the same time, a building can house both.

On pages 36 and 37, figure 9 shows the results that can be combined, taking in mind that regarding "site" the option of being far away from the campus centre, was deemed best combinable with the results in the other domains, such as "tranquility".

OVERVIEW OF NEURODIVERSE STUDENTS' RESULTS

SPACE/FORM	**Small spaces**
MATERIAL/STRUCTU.RE/CLIMATE	**Well lit** **Good construction** **Calm colours**
FUNCTION/ROUTE	**Not in the walking path** **No multi-use building**
SITE	Far away from the campus centre or at own faculty Not too busy outside
CONTEXT	**Tranquil** **A small number of people who are studying** Control over the space

Figure 8a: Overview of neurodiverse students' results.

OVERVIEW OF NEUROTYPICAL STUDENTS' RESULTS

SPACE/FORM	**Big sectioned space**
MATERIAL/STRUCTU.RE/CLIMATE	**Light**
FUNCTION/ROUTE	**Not in the walking path**
SITE	**Central location**
CONTEXT	**Tranquil** **Study atmosphere**

Figure 8b: Overview of neurotypical students' results.

	RACHEL	MARK	EMMA	STEVEN	JORT	TUGBA
SPACE/FORM	**Small spaces** **Narrow spaces**	**Small spaces** Cubicles for group work	Large glass wall for looking outside	**Big sectioned space**	**Big sectioned space** **High ceilings (and variation in height)** Overview of the space	**Open space** **Lots of space** Not too high ceilings
MATERIAL/STRUCTU-RE/CLIMATE	**Light** Large windows with sunscreens Light colours	Good construction Not too noisy	**Well lit** **Warm light** Natural light **Carpeted floors** **Good construction** **Calm colours**	**Light** No dark colours Not just white	**Light** **Well constructed** **Not too warm** Plants are nice Low ceilings more light Red accents	**Light** Plants Variety White White desks focusses View of the street Large windows
FUNCTION/ROUTE	Not in the walking path **Enough poweroutlets** View of the door Close to amineties No multi-use building	**Just for studying**	**Not in the walking path** No food smells	**Not in the walking path** Clear route PC screens	**Not in the walking path** **Large desks** **Adjustable seating** **Printers close by** Power outlets Nice space for breaks	**Coffee close by** Lots of different sea-ting areas
SITE	**Far away from the campus centre** Not too busy outside	-	At ones own faculty feels familiar Green surroundings	-	**Central location** **View of water and trees** View of cyclists from afar	Central location
CONTEXT	**Tranquil** **A small number of peo-ple who are studying** Control over the space Not too quiet Small amount of movement outside	**Overview** Not too busy Not too loud Tranquil studyspace Serious people	**Tranquil** Social control Control over the light	**Tranquil** **Study atmosphere** A few people	**Quiet** Serious people	**People that do the same** People with their own expertise nearby Inspiring Not too quiet People who (seem to be) studying

Figure 7: Overview of all the students results with in white what clashes.

	NEURODIVERSE		NEUROTYPICAL
SPACE/FORM	Small spaces Narrow spaces Cubicles for group work Large glass wall for looking outside	+	Big sectioned space Open space Lots of space Overview of the space
MATERIAL/STRUCTURE/CLIMATE	**Well lit** Warm light Natural light, **large windows** with sunscreens Carpeted floors **Good construction** Not too noisy Calm, light colours	+	**Light, large windows** **Well constructed** Not too warm Plants No dark colours, white, but not only white Variety View of the street
FUNCTION/ROUTE	**Not in the walking path** **Enough poweroutlets** View of the door **Close to amenities** but no food smells No multi-use building	+	**Not in the walking path** Large desks with and without PC screens and adjustable seating A variety in seating areas **Printers and coffee close by** **Power outlets** Nice space for breaks
SITE	Far away from the campus centre Not too busy outside Green surroundings	+	View of water and trees View of cyclists from afar
CONTEXT	**Tranquil** **A small number of people who are studying** but not too busy Control over the space **Not too quiet**, not too loud Small amount of movement outside	+	**Tranquil** **A small number of people who are studying** Study atmosphere **Not too quiet**

Figure 9: Overview of the results that are compatible with each other.

C ITY SCALE

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When searching for a home, the location is deemed the most important factor. This can be thought of as just as important in learning environments as it is deemed in housing.

According to Attention Restoration Theory (Bell, 2001), directed attention (studying) drains ones amount of attention. This means that there is a finite amount of attention available to a person at a certain time.

People with Attention Deficit Disorder (ADD), for instance, have what can be described as a faulty impulse filter. Every noise made or shift seen is registered, whereas a neurotypical person would not actively notice these impulses. The effect this has on people with ADD is that their amount of attention draines more rapidly and could therefore be in need of replenishment sooner.

As the pool of attention drains, it becomes increasingly difficult to focus and therefore study. According to Kaplan, nature is the way to replenish ones attention amount. In his article *The restorative benefits of nature* he describes four components of restorative environments, namely: Being away, Fascination, Extent and Compatibility. These four components are well represented in nature, making it the ideal environment to restore ones attention. (Kaplan, 1995)

This was also agreed upon by the interviewees. Both neurotypical and neurodiverse students listed view of greenery as a positive

attribute. Rachel also stated that she would like the building to be far from the city centre as this would result in less people, more nature and less hustle and bustle.

Aside from proximity to nature, noise levels can have a great impact on study-achievements and are therefore important to consider when desiging. Noise can impact performance greatly, both during exposure and through aftereffects (possibly due to draining ones attentionlevels) (Bell, 2001). "[noise]... "masks" internal speech, or makes it more difficult to "hear ourselves think"" (Poulton, 1977). Additionally, quiet or tranquility was mentioned by all but one interviewee as an important factor in the succes of the study environment. Therefore, positioning the building in its context so that places of concentration are more quiet is advisable.

B
UILDING SCALE

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The students interviewed had a lot of input on their environment in the building scale. I will firstly adress the issues where the neurotypical and neurodiverse students were in agreement. After that, I will discuss the differences of opinions.

The main element all interviewed students agreed upon was that a studyspace should not be in the walking path. For all students it is very distracting to have people walk past regularly: the environment must be tranquil. As mentioned in the City Scale, tranquility was named by all but one student. This seems to be an important factor in the make-or-break of the educational environment. However, even though the students wish the environment to be tranquil, they don't wish it to be devoid of others. All interviewees voiced their wish for there to be other students who are also studying. This creates a study atmosphere that motivates. This way there is also a sense of social security and purpose: you feel less inclined to slack off when people around you are hard at work.

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Lastly, the students agreed on the need for well constructed spaces. They found the need for better attention paid to especially how floors are constructed. It is very distracting when you bounce up and down in your chair when a person walks past or uses the

stairs because the construction of the floor is not sturdy enough.

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Lastly, regarding the space sizes, the neurotypical and neurodiverse students differed greatly. The neurotypical students opted for larger, but sectioned, spaces, while the neurodiverse students opted for smaller spaces, preferably longer than they are wide. This could perhaps be due to the need of some neurodiverse people to keep an overview of their surroundings but could also benefit neurotypical students such as Stephen.

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Inside the room, materials are the most important element since materials have the ability to abate many an impulse. Softer materials such as carpets and fabrics can be instrumental in absorbing sounds, such as footsteps or conversations. However, the colours of the materials used could also form an impulse in itself. Four out of the six students interviewed discribed that they liked either "calm colours" or "not just white". Emma listed white in the same breath as harsh colours, indicating that white might well be a harsh colour. It could therefore be better to look into pastels, darker shades or natural materials. I believe it's not neccesary to forgo all use of the colour white, but the understanding that white is the most basic colour, and therefore low-impulse, is in my opinion, a misconception.

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During the designprocess it could therefore be vitally important to realise this since it can impact the user greatly. One way to relie-

ve the issue could be to grant the user some form of control. The ability to be able to turn the heat on, change the light intensity, shut the blinds, close or open doors and windows, provides the user with a possibility to cope with the original impulse. The more control we have, the better we adapt to impulses (Bell, 2001). Control over the environment was favourably mentioned by two of the three neurodiverse students.

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"Excersising meaningful control over environmental conditions allows the individual to tailor them to one's needs and preferences. By definition, the conditions one prefers should be those that produce high environmental satisfaction." (Marquardt, Veitch, & Charles, 2002)

CONCLUSION

This thesis has been aimed at finding out how the needs and wishes of neurotypical and neurodiverse students can be combined to create an inclusive study facility at the TU Delft.

From figures 7, 8a, 8b and 9, it can be concluded that though the needs and wishes of neurotypical and neurodiverse students sometimes differ, they are generally not excluding one another. It however also becomes clear that when they do, the consequences for neurodiverse students can be greater than the consequences for neurotypical students. It is therefore pertinent to opt to weigh the scales more in favour of neurodiverse students.

For the city scale, this entails that a quiet location surrounded by nature is best. This is favoured by both neurotypical and neurodiverse students and agreed upon by Kaplan.

In the building scale, neurodivergent students wish for smaller spaces with a better overview. Diametrically opposed to that are the wishes of neurotypical students to have larger, albeit sectioned spaces. To provide both will eleviate the strain on the smaller spaces, and keep them tranquil. The building layout should be clear and logical with hallways alongside studyspaces. The building's construction should be sturdy and sound while still letting enough natural light in.

Finally, the room scale is where calmness and control are most important. Calm colours and soundabsorbant materials create

the atmosphere while being given control could help eleviate stress by letting the students cope with the impulse.

DISCUSSION

I believe this thesis is a first step in emphasising the need for more research in the area of designing inclusively and especially for neurodivergent people. While a lot of research has been geared towards the most severe cases of neurodivergence, as it should, the moderate cases have been left to struggle to try and force themselves to fit into a society that is just not built for them. In my opinion, the zeitgeist of this era is shifting from the (egocentric) view of the median person, towards the view of people: as they are. I believe this could make for a society where not only the median person is appreciated, but all people are appreciated. As IT Vitae said to my brother when he first walked in: "So you're on the autism spectrum, congratulations! We need you in our society!".

I hope my research has the ability to open minds to the idea that designing for both neurotypical and neurodivergent people is very easy. The only thing the designer needs to do is understand why certain needs are different and shift priorities accordingly.

Due to the small research sample size, the recommendations in this thesis might need to be based on much broader research. It however, does show the difference in wishes and needs of neurotypical and neurodiverse students at the TU Delft, their compatibility and therefore the viability of further research.

Superficially, it might seem that there is one outlier in this research: Tugba. However, I believe that for this research, Tugba demonstrates the diversity in students and is therefore not an outlier.

Much as I would have wished to research the needs and wishes of all students at the TU Delft, this would be far beyond the scope of a normal graduation thesis, but I do strongly believe more research should be done into how the built environment functions for different groups of students. This could, for instance, be students with other impairments, be it physical or mental, international students or LGBTQI+ students.

There is but one median student. What about the other 24.702?

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APPENDIX

INTERVIEW OPZET

Personalia
Man/Vrouw? Leeftijd?
Welke studie doe je?
In welk jaar zit je?
(Wat doe je meestal als je studeert?)

(Non) neurotypical
Heb je een beperking? Zo ja, wat precies?
Hoe beïnvloed dat je dagelijkse bezigheden?
Hoe beïnvloed dat je studie? Hoe heb je ermee om leren gaan?
Wat doe je dan?
Mis je een prikkelarme studieruimte?

Fijnste studieruimte
Wat vind jij de fijnste ruimte om te studeren op de TU Delft?
Wat voor studeren doe je daar?
Studeer je in je eentje?
Waarom die ruimte? Waar zit het hem in dat je dat de fijnste ruimte vindt?

Domeinen
Wat vind je van de ruimtelijkheid van de ruimte? De vorm, compositie, grootte, hoogte,...
Wat zie je als je daar zit?
Hoe zit het met de ramen?

En het licht?
Is de temperatuur fijn?
Heb je een mening over de materialen die gebruikt zijn?
Kleur?
Geluid?
Hoe kom je er? Welke route moet je doorlopen?
Heb je een ritueel daar? Een vaste plek?
Hoe zit het met pauzes?
Lopen er mensen langs?
Waar ligt het op de TU? Maakt dat uit?
Wat ligt er naast? Heb je het gevoel dat dat je beïnvloed?
Beschrijf alsjeblieft de sfeer die doorgaans in die ruimte hangt
Waardoor komt die sfeer daar?
Met welk humeur ga je daar meestal naartoe?
Heeft de ruimte de mogelijkheid om je humeur te veranderen?

Verbeterpunten
Wat zou je nog kunnen verbeteren aan deze ruimte?
Mis je verder nog iets dat je zou kunnen helpen met studeren?

Minst fijne studieruimte

Studieruimte buiten de TU

Pulse

Overig
Heb ik nog iets gemist? Of heb je nog wat toe te voegen?

ARCHITECTS' HANDBOOK

FOR THE DESIGN OF STUDY SPACES FOR NEURODIVERSE STUDENTS

THERESE M.
TEGELBERG
4219589

ARCHITECTS' HANDBOOK

FOR THE DESIGN OF STUDY SPACES FOR NEURODIVERSE STUDENTS

PART OF THE MASTER'S THESIS OF
THERESE M. TEGELBERG

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Third mentor (research):
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23-10-2020

P REFACE

Thank you for taking the time to read this handbook. While multiple studies have been conducted surrounding the educational physical environments of children who are neurodivergent*, I have found that little research has been done into the physical educational environments for adults who are neurodivergent. This is a growing issue because society is becoming more and more inclusive and diagnoses are on the rise (Visser, et al., 2014) (New York Times, 2002).

For my master's thesis I have conducted semi-structured interviews with both neurotypical and neurodiverse students at the Technical University in Delft, The Netherlands. This resulted in many recommendations regarding their preferred studying environments. This handbook is based on a study with six interviewees but the results indicate that much broader research would be beneficial.

I would like to thank all the people who have made this possible. My tutors, Martijn Stellingwerff, Elise van Dooren and Freek Speksnijder who have helped me persevere. The interviewees who spoke so candidly and provided me with such an abundance of information. Frans de Bie, founder and director of the foundation IT Vitae Learning, where adults with Autism Spectrum Disorder can get an IT education, for showing how they work and have created their educational spaces. Eise Könst and my brother Michiel Tegelberg for enlightening me how they perceived the IT Vitae environment. And finally my parents and fiancé who supported me through this hectic and weird graduation year.

*Neurodivergent can be defined as a person whose neuro-cognitive functioning diverges significantly from the dominant societal standards of "normal".

"Neurodivergence (the state of being neurodivergent) can be largely or entirely genetic and innate, or it can be largely or entirely produced by brain-altering experience, or some combination of the two (autism and dyslexia are examples of innate forms of neurodivergence, while alterations in brain functioning caused by such things as trauma, long-term meditation practice, or heavy usage of psychedelic drugs are examples of forms of neurodivergence produced through experience)." (Walker, 2020)

TABLE OF CONTENT

INTRODUCTION

This handbook contains ways in which architects could fairly easily design interventions, keeping neurodivergent students in mind. The ideal scenario would be to be able to take every user into account, but that is sadly not possible. This handbook is meant to make architects aware of design solutions to create better study environments for more than the median user.

Alongside this, extra insights are given into two diagnoses to highlight where the design solutions originate and how they could aid in making life easier for people with these diagnoses. This will provide you with the knowledge to look further for solutions that best suit your design.

CITY SCALE

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When searching for a home, the location is deemed the most important factor. This can be thought of as just as important in learning environments as it is deemed in housing.

According to Attention Restoration Theory (Bell, 2001), directed attention (studying) drains ones amount of attention. This means that there is a finite amount of attention available to a person at a certain time.

People with Attention Deficit Disorder (ADD), for instance, have what can be described as a faulty impulse filter. Every noise made or shift seen is registered, whereas a neurotypical person would not actively notice these impulses. The effect this has on people with ADD is that their amount of attention draines more rapidly and could therefore be in need of replenishment sooner.

As the pool of attention drains, it becomes increasingly difficult to focus and therefore study. According to Kaplan, nature is the way to replenish ones attention amount. In his article *The restorative benefits of nature* he describes four components of restorative environments, namely: Being away, Fascination, Extent and Compatibility. These four components are well represented in nature, making it the ideal environment to restore ones attention. (Kaplan, 1995)

This was also agreed upon by the interviewees. Both neurotypical and neurodiverse students listed view of greenery as a positive

attribute. For instance, one of the interviewees, Rachel, also stated that she would like the building to be far from the city centre as this would result in less people, more nature and less hustle and bustle.

Aside from proximity to nature, noise levels can have a great impact on study-achievements and are therefore important to consider when desiging. Noise can impact performance greatly, both during exposure and through aftereffects (possibly due to draining ones attentionlevels) (Bell, 2001). "[noise]... "masks" internal speech, or makes it more difficult to "hear ourselves think"" (Poulton, 1977). Additionally, quiet or tranquility was mentioned by all but one interviewee as an important factor in the succes of the study environment. Therefore, positioning the building in it's context so that places of concentration are more quiet is advisable.

BUILDING SCALE

The students interviewed had a lot of input on their environment in the building scale. I will firstly address the issues where the neurotypical and neurodiverse students were in agreement. After that, I will discuss the differences of opinions.

The main element all interviewed students agreed upon was that a studyspace should not be in the walking path. For all students it is very distracting to have people walk past regularly: the environment must be tranquil. As mentioned in the City Scale, tranquility was named by all but one student. This seems to be an important factor in the make-or-break of the educational environment. However, even though the students wish the environment to be tranquil, they don't wish it to be devoid of others. All interviewees voiced their wish for there to be other students who are also studying. This creates a study atmosphere that motivates. This way there is also a sense of social security: you feel less inclined to slack off when people around you are hard at work.

Another element the students agreed upon was lighting, for when you cannot read a text, you cannot comprehend the text. Emma elaborated on this element further, stating she prefers warm and natural light, while others expressed their need for large windows.

Lastly, the students agreed on the need for well constructed spaces. They found the need for better attention paid to especially how floors are constructed. It is very distracting when you bounce up and down in your chair when a person walks past or uses the stairs because the construction of the floor is not sturdy enough.

Regarding the elements where the groups differed in opinion, an important element is the setup of the building with its uses. Part of the Autism Spectrum Disorder (ASD) diagnosis in DSM-5 is "Insistence on sameness [...] (e.g. extreme distress at small changes, difficulty with transitions, rigid thinking patterns [...]" (American Psychiatric Accosiation, 2013). This means that if a person with ASD finds themselves lost for example, their stresslevels rise far more than a neurotypicals stresslevels. To make sure the risk of this occuring is lowered, it is important to think about the predictability of the main layout of the building. When a building is sorted logically in use, and therefore predictible, it should be far less likely for a person to feel lost. In my research, Mark and Rachel expanded on this by stating they would like a single-use building. By designing a building where it is abundandly clear what the use is, since there is but one, it inherently becomes far more predictably and there are less transitions to overcome.

Lastly, regarding the space sizes, the neurotypical and neurodiverse students differed greatly. The neurotypical students opted for larger, but sectioned, spaces, while the neurodiverse students opted for smaller spaces, preferably longer than they are wide. This could perhaps be due to the need of some neurodiverse people to keep an overview of their surroundings but could also benefit neurotypical students such as Stephen.

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Inside the room, materials are the most important element since materials have the ability to abate many an impulse. Softer materials such as carpets and fabrics can be instrumental in absorbing sounds, such as footsteps or conversations. However, the colours of the materials used could also form an impulse on itself. Four out of the six students interviewed discribed that they liked either "calm colours" or "not just white". Emma listed white in the same breath as harsh colours, indicating that white might well be a harsh colour. It could therefore be better to look into pastels, darker shades or natural materials. I believe it's not neccesary to forgo all use of the colour white, but the understanding that white is the most basic colour, and therefore low-impulse, is in my opinion, a misconception.

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EPILOGUE

I hope this has given you an initial insight into the needs and wishes of both neurotypical and neurodiverse students and that this will help you when designing future inclusive educational environments.

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