Neurodiversity and Active Travel – an evidence review

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Executive Summary

This report reviews available literature on neurodiversity and active travel, and related literature, using robust definitions of neurodiversity, neurodivergence, and related concepts.

This research was funded by Transport Scotland, through the Scottish Research Programme, and carried out by Sustrans.

Approximately 20% of the UK's population is neurodivergent and neurodiversity is an important axis of identity which intersects with other identity characteristics to create differential experiences of travel. Understanding how neurodiversity impacts people's travel choices and experiences is vital to removing barriers neurodivergent people currently face in society, especially surrounding transport poverty and the transport accessibility gap. Furthermore, this understanding could enable more groups to use active travel and thus support transport decarbonisation.

The report's findings show that neurodiversity impacts all elements of active travel, from travel choices to experiences of the journey. Research and other reviewed literature highlights **common impacts experienced by neurodivergent people**:

Travel is often an overwhelming and tiring experience for neurodivergent people. This is partly due to difficulties with journey planning and wayfinding because of inconsistent infrastructure design, unexpected changes, and insufficient communication. Physical inaccessibility of the built environment also contributes to neurodivergent people's experiences of overwhelm and fatigue during travel. These physical accessibility concerns include pavement parking, poorly maintained or uneven pavements and lack of rest places.

Physical characteristics of some neurodivergent conditions make public space and travel environments inaccessible to some neurodivergent people. For example, public spaces such as streets and paths can be anxiety-inducing for people with sensory sensitivities. Moreover, many

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neurodivergent conditions impact people's balance and spatial awareness, meaning physically inaccessible environments are more tiring and hazardous to navigate.

Further barriers to active travel are associated with poverty, safety concerns, and lack of input into communities and decision-making. Neurodivergent people are disproportionately likely to live in poverty, and poverty significantly limits travel and travel choices. Moreover, research shows neurodivergent people feel less safe within their local communities and less able to contribute to their communities compared to the general population. These factors inhibit travel choices and their ability to input into making travel easier and more accessible for neurodivergent people.

Because of these and other barriers to travel, **many neurodivergent people limit the amount they travel as a strategy to lessen the negative impact of travel on their lives**. This limits neurodivergent people's access to opportunities, places, people, and services.

The research recommends many strategies to alleviate the identified barriers, including:

- Provide **sensory choice** wherever possible in public space and using design techniques to, for example, dampen sound or provide sunshade
- Ensure the travel environment is as **physically accessible** as possible, by, for example, improving pavements, eliminating pavement parking, and increasing the number of public toilets and rest areas.
- **Separate transport modes** to provide more space on the pavement for people walking and wheeling
- Make travel environments **simple and consistent** with easy to access and understandable journey planning information
- Introduce **more funding** for neurodivergent and other disabled people's transport as well as **expanding existing schemes**, such as the Disabled Person's Railcard and Motability, to cover neurodivergence.

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- Give neurodivergent people **a role in decision making processes**, especially regarding decisions that impact them.

Neurodiversity and neurodivergence is an emerging area of research, with many **opportunities for future research**. These include quantifying neurodivergent people's mode choices and better understanding the specific needs of neurodivergent people that are not always well captured when literature and strategies only use a general category of disability.

Similarly, **Scottish and UK policy has room for growth** in its specific attention to neurodivergence and active travel, aspri neurodivergence policy does not address travel, and disability and travel policy does not adequately address neurodivergence or active travel. Future research could underpin further policy and strategy to enable neurodivergent people to travel more easily and therefore experience more opportunities, and contribute to increasing active travel use.

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Introduction

The Scottish Research Programme

Sustrans' Scottish Research Programme funded this study. The Scottish Research Programme provides funding for research that advances understandings of, and generates evidence relating to, walking, wheeling and cycling. The programme is administered by Sustrans' Research and Monitoring Unit (RMU) as part of Transport Scotland's Active Cities and Towns Grant.

Aim and research question

The aim of this report is to understand the connections between neurodiversity and active travel, focusing on the experiences of neurodivergent people. Improved understanding of this is necessary to create travel systems which enable all members of society to access all the opportunities of public life. Neurodiversity is an important axis of identity which intersects with other identity characteristics to create differential experiences of travel. Understanding how neurodivergence impacts people's travel choices and experiences is vital to removing barriers neurodivergent people currently face in society, especially surrounding transport poverty and the transport accessibility gap. Furthermore, this understanding could help create more diversity in active travel use, which is necessary for transport decarbonisation. The hope is that this report can contribute to the growing field of research into neurodiversity and travel, with a focus on active travel (walking, cycling, and wheeling).

The research question was:

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How do various neurodivergent conditions impact on people's active travel choices and active travel experiences?

Neurodiversity and neurodivergent are defined below under **Paradigm and definitions**. Neurodivergent people's needs are less likely to be met by travel systems than those of non-neurodivergent people. As such, most literature on neurodiversity and active travel, including this report, focuses on neurodivergent people's needs, and the research question is phrased to reflect this.

Research objectives

The objectives of this literature review were to:

- Identify robust definitions of neurodiversity and neurodivergence for Sustrans to use in the future
- Complete a thorough literature search – including grey literature – of research on neurodivergence in relation to active travel
- Develop a thorough understanding of the policy landscape in Scotland related to neurodiversity and active travel
- Develop a better understanding of:
    - How various neurodivergent conditions affect people's travel choices and travel experiences
    - How neurodivergent people currently experience their active journeys from mode choice to travel environment
    - The various barriers to and enablers of active travel for neurodivergent people
    - Any existing active travel policies or strategies for neurodivergent people.
- Identify research gaps which Sustrans (and other researchers) could fill in future.

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Paradigm and definitions

The terms neurodiversity and neurodivergence originated as part of the neurodiversity paradigm, developed by autistic activists in the 1990s as part of the disability rights movement.[1] In using this language, this report also uses the neurodiversity paradigm. The Neurodiversity Paradigm is an emergent paradigm in which neurodiversity is understood to be a form of human diversity that is subject to the same social dynamics as other forms of diversity (including dynamics of power and oppression).

The neurodiversity paradigm is underpinned by the Social Model of Disability.[2,3] The Social Model of Disability focuses on disablement caused by barriers and inaccessibility of society, as opposed to the dominant medical model that focuses on disablement caused by impairment or difference.[4] It is outlined in more detail in **Appendix A**: see **Social model of disability**.

Neurodiversity

In the neurodiversity paradigm employed in this report, *Neurodiversity* refers to the diversity between everyone and affirms that such difference is natural and normal.[5] Firstly, there is diversity between people with various neurological conditions or no identified conditions. Everyone's brain is different. Even two individuals with the same neurological diagnoses do not think and experience the world in exactly the same way.[3,6] Secondly, there is no 'right' or 'wrong' way for the human brain to process its environment. Differences are not deficits, but instead are neutral and natural variations.[6]

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Neurodivergence[a]

Neurodivergence encompasses any neurological condition that falls outside what most people would consider to be 'normal' or 'neurotypical' (defined in **Appendix A**: see **Neurotypical**). Lists of conditions included under the neurodivergent umbrella vary but generally include autism, attention deficit hyperactivity disorder (ADHD), Tourette's syndrome, dyspraxia, obsessive compulsive disorder (OCD), dyslexia, and sensory processing disorder (SPD).[2,3,7–10] Estimates from various studies suggest approximately 15–20% of the UK population is neurodivergent, though estimating prevalence is difficult due to different definitions and many people not diagnosed or aware of their neurodivergence.

Neurodivergent people have a wide range of different ways of socialising, communicating, wayfinding and sequencing (discussed under **Wayfinding**), interpreting, perceiving, and sensing compared to the general population. There is, of course, also considerable diversity of experience among neurodivergent people. Therefore, when discussing how neurodivergent people experience the world, what is true for one neurodivergent person may not be true for another. As Lawburg summarises:[8]

> "Each neurodivergent person has their own unique experiences relating to the world around them."

Neurodivergent people's needs must be explored and accommodated, but also this diversity of experience needs to be taken into account.

Neurodivergent people are generally considered disabled because most or all struggle with some aspects of daily life in society. Overall, this amounts to disability under most

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[a] Other key terms relating to Neurodivergence are outlined in Appendix A: key terms and definitions and Appendix B: brief overview of some neurodivergent conditions

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understandings of disability and under the Equality Act 2010.[11] Although some neurodivergent people do not consider themselves disabled, neurodivergence is included under the umbrella of disability for the purposes of this literature review. The difference between the category of those defined as disabled under the Equality Act and those identifying as disabled results in some people considered disabled in this review not being included in datasets which require self-identification of disability. Finally, in this report, the term 'disabled people' is intended to encompass a broad range of disabilities, including learning disabilities, although, later in the report, we distinguish between the two categories, recognising that people with learning disabilities don't necessarily consider themselves disabled. This report acknowledges the unique identities and challenges faced by these communities.

Preferred terminologies

As with identifying as disabled, not all people meeting the definition of neurodivergence used in this report would identify as neurodivergent. Individuals have their own understandings of and preferences about terminology to describe themselves.[b] Terms are also used in different ways beyond self-identification. For example, in some literature and discussion, the term 'neurodiverse' is used for what is more precisely termed 'neurodivergent'.[12]

Within the neurodiversity paradigm, it is generally preferred to use language that suggests neurodivergence is a neutral part of a person's identity. This means avoiding pathologising language. It also generally means avoiding distancing 'person-first' language which, despite the intention to be respectful, can imply stigma or pathology.[5,13,14] In this report, straightforward 'identity-first' language is used: for example, neurodivergent

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[b] Some people may prefer the term neurodiverse, others neurodivergent, others neurominority, and others may not identify as part of this umbrella community at all.

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people, disabled person. Pathology language for neurodivergent conditions is also avoided where a widely used alternative is available: for example, autistic or autism rather than autism spectrum disorder. However, for many neurodivergent conditions, there are not widely recognised neutral terminologies at the time of writing this report, so the standard pathology language is used.[c]

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[c] See discussion of terminology for ADHD in Appendix B: Attention Deficit Hyperactivity Disorder (ADHD).

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Method: literature review

This report is a literature review. In order to answer the research question *How do various neurodivergent conditions impact on people's active travel choices and active travel experiences?*, literature from a variety of disciplines was examined, including:

- Architecture
- Social geography
- Disability studies and advocacy
- Autism studies
- Transport planning
- Urban design.

Furthermore, a wide variety of types of literature were reviewed, including:

- Journal articles
- Academic books
- Academic theses
- Research reports by relevant third sector organisations
- Local Authority Accessibility reports
- Government reports and statistics
- Blog posts written by neurodivergent and/or disabled individuals.

The majority of the literature comes from the UK, although sources from Ireland and the USA are included.

Inclusion of pan-disability and other related literature

Neurodivergence and active travel is an emerging area of research so currently there is little published material on this specific topic. However, there is significant research into the field of disability and active travel and in much of this literature, disability includes neurodivergent conditions. Therefore, research about general disability, which includes neurodivergent conditions, has been reviewed. This pan-disability literature does provide very useful insight, such as highlighting key patterns and concerns for neurodivergent and other disabled people. However, much more research is required to investigate specifically how these patterns impact neurodivergent people within the broader disabled community.

There is more research available on neurodivergence and travel in general, and neurodivergence and experiences of public space and the city street. This literature is also included in this report for similar reasons.

Findings

Mode choice

As noted above, further research is needed on the specific topic of neurodivergence and active travel. This is particularly a problem regarding research quantifying mode choice for neurodivergent people. The most useful source on mode choice was The *Streets for Diversity* report into Neurodivergent people's experiences of the street.[3] Even here, mode choice for neurodivergent people was only touched on as part of the report. The report's main focus was design recommendations to create more inclusive public spaces for neurodivergent people.

Neurodivergent people's mode choice is measured as part of general disability and travel research. An important source here is Transport for All's report *Are we there yet?*[15] which included an analysis of the Department for Transport's National Transport Survey as well as their own survey to quantify mode choice among disabled people.

Walking and wheeling

There are indications that walking and wheeling may be frequently used modes of transport for neurodivergent people. *Streets for Diversity*[3] survey respondents liked the health benefits of walking and said that if they had a choice between public transport and walking, they would choose to walk.[3]

In terms of general disability data, analysis of the Department for Transport's 2022 National Travel Survey data shows that walking/wheeling trips account for 28% of all journeys made by disabled people and it is the second most frequently used mode (after car travel).[15] Nonetheless, in England disabled people take 30% fewer walking trips than non-disabled people, demonstrating the inaccessibility of walking/wheeling.[4]

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Disabled people often find their walking and wheeling journeys difficult. Transport for All[15] asked survey respondents to rate the ease of their walking/wheeling journey on a scale of 0 to 3, with 0 representing 'I cannot use/do this at all' and 3 representing 'I use/do this with confidence and ease.'[15] Walking/wheeling scored an average of 1.86, indicating that many disabled people face difficulties in their walking and wheeling journeys.

Cycling

As for other modes, there is very limited quantitative data on cycling use among neurodivergent people and this is a clear area for further research. As with walking and wheeling, some research may give indications about mode preference. Research with neurodivergent people found that some neurodivergent participants preferred cycling to walking in instances where walking caused them pain because of physical conditions.[3] This research also showed that some neurodivergent people preferred cycling (and taxis) to other forms of transport as they linked these with autonomy.[3]

Transport for All's Analysis of the 2022 National Travel Survey on general disability statistics shows that cycling has the lowest mode share among disabled people: on average disabled people make two cycling journeys per year compared to 17 journeys for a non-disabled person.[15] Many disabled people cannot cycle – between 75% and 85% depending on the data source.[15,16]

However, some argue that these statistics disguise the diversity within cycling.[4,15,17–19] Many disabled people are keen cyclists and report finding cycling more accessible than walking/wheeling as they use their cycle as a mobility aid.[d4,15,16] This may particularly be the case for neurodivergent people in light of the above data about some neurodivergent people preferring cycling to other transport modes.

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[d] As discussed below, physical accessibility and the needs for mobility aids are still applicable to neurodivergent people.

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Public transport

Little data exists quantifying public transport mode choice for neurodivergent people.

In general disability research, a significant amount of the research into disability and travel concerns public transport use, despite it not being a particularly commonly-used transport mode among disabled people and many disabled people reporting accessibility barriers.

Around 50% of disabled people in the UK lack car access and are therefore viewed as being dependent on public transport to travel.[16] It is true that disabled people make a greater proportion of trips by bus than non-disabled people, but bus travel accounts for a 5% mode share for the average disabled person (and 3% for non-disabled people).[15] Furthermore, disabled people make fewer train and light rail trips than non-disabled people.[15]

Despite the perceived dependence on public transport for disabled people, it is often inaccessible. Between 10% and 16% of TFA survey respondents reported not being able to use public transport at all (depending on the specific mode),[15] and other research has found 20% of disabled people find public transport inaccessible.[16]

Car and taxi travel

Neurodivergent-specific qualitative research found that taxis and private hire vehicles were a popular transport mode, but no data was found quantifying actual mode use. Research participants described using taxis to alleviate their struggles with **Wayfinding**(discussed below) as well as a strategy to reduce the mental and physical exhaustion associated with travel (discussed in the **Travel causes fatigue and stress** section).[3]

For the overall disabled category, car and taxi travel comprises a significant mode share for disabled people and it is viewed by many as the easiest and most accessible way to travel.[15] Car travel mode share for disabled people seems very similar to

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that of non-disabled people: car journeys made up 61% of disabled people's travel while they comprised 60% of non-disabled people's travel in the UK in 2021.[15] Disabled people are more likely to travel as car passengers, however, and journeys as a car passenger account for 19% of disabled people's mode share compared to 12% for non-disabled people.[15]

Despite car travel playing such a significant role in disabled people's travel, private cars are inaccessible to many disabled people. Almost 30% of disabled adults live in a household that does not have car access (for non-disabled adults, the figure is 15%) and nearly 40% of disabled adults do not have a full driving licence (less than 20% of non-disabled adults do not have a full driving licence).[15]

Because walking/wheeling, cycling, public transport and private car travel is inaccessible to various extents for disabled people, taxis and private hire vehicles play a significant role in their travel.[3,15] National Travel Survey analysis found that disabled people make twice as many taxi trips per year compared to non-disabled people.[15]

Not travelling as a mode choice: the transport accessibility gap

The *transport accessibility gap* refers to disabled people (including neurodivergent people) taking fewer journeys than non-disabled people as a result of travel systems being inaccessible to disabled people.[4,16]

Neurodivergent individuals avoiding travel because of the many difficulties they face in their journeys was a significant theme in the literature.[3,8,20,21] Kenna's survey of neurodivergent individuals in Cork, Ireland, found that 40% of respondents identified transport as the aspect of city-life they find most challenging.[20] This suggests it is likely neurodivergent people face a significant transport accessibility gap, and further research quantifying mode choice is necessary to measure and address this likely inequity.

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When looking at disability and travel in general, disabled people take an average of fewer than 6 journeys per week compared to the national average of 17 trips per week (across all modes).[15]

The transport accessibility gap results in neurodivergent people having reduced access to opportunities compared with neurotypical and non-disabled people, as they have unequal access to travel. Furthermore, inaccessibility of travel contributes to the risk of social isolation faced by many neurodivergent people. As Transport for All wrote in their report on barriers to travel faced by disabled people in 2023:[15]

> "Disabled people do not have equitable access to any mode of transport, and the impacts of this injustice can be felt in every corner of our lives."

This inequity can be addressed by understanding and acting in response to

- the barriers neurodivergent people face when travelling
- the potential solutions to overcome these barriers
- the factors than enable neurodivergent people to travel more.

Barriers and enablers to travel

The majority of the literature focused on the barriers faced by neurodivergent individuals when travelling or in public space. Some researchers also put forward solutions to the issues faced by neurodivergent people or described strategies and tools neurodivergent people already use to make their journeys easier. Some of these strategies may contradict each other or at least not be compatible, and further research is required to develop a cohesive toolkit that would enable active travel among neurodivergent people.

The major barriers to travel for neurodivergent people and the potential solutions to these barriers are outlined below.

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Sensory overwhelm

Many neurodivergent people report being very sensitive to light, noise, smells, taste, different textures and also claustrophobia. These sensitivities cause stress, overwhelm, and sometimes panic attacks or meltdowns.[2,3,8,9,20,21] This can be compounded with other sources of stress and overwhelm related to travel, as discussed in **Travel causes fatigue and stress**. Sensory Processing Disorder (described in **Appendix B: brief overview of some neurodivergent conditions**) is a common neurodivergent condition and sensory processing differences are often experienced by people with other neurodivergent conditions.[3]

Public transport and sensory overwhelm

Public transport was often cited as a location for sensory overwhelm. Many neurodivergent people described the discomfort they experienced on buses and trains due to heat, noise, strong smells, harsh lighting and overcrowding.[3,15,20] Transport for All's pan-disability survey found that 49% of disabled people find overcrowding on trains a barrier to train travel, as it stops them from moving through the train and also causes sensory overwhelm.[15] A further 23% reported environmental factors, such as light, sound and smell, negatively impacted their train travel.

The city street and sensory overwhelm

Various aspects of the city street also cause sensory overwhelm, which impacts neurodivergent people's travel. Neurodivergent people described the busyness of streets as causing claustrophobia. A neurodivergent participant in the *Disabled Citizens' Inquiry* described how sensory sensitivities impacted their walking journeys through the city:[4]

"My autism, ADHD, anxiety and depression mean I really struggle in busy and dense city spaces. It's intense for me to be surrounded by lots of people. It feels like they're all walking directly towards me, and that everything is

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The noise of the city street is also a barrier to travel for neurodivergent people. Loud noises, such as construction work or cars zooming past, can cause panic, overwhelm or even physical pain.[2,3,20,21] An autistic individual described the sound of passing cars feeling like an explosion inside them, sometimes causing them to scream and cover their ears.[2]

However, it is not just loud noises but also the combination of all the different noises of the city which causes discomfort.[2,3,20,21] While **Neurotypical** people are able to filter out various background noises to focus on their task, many people with sensory processing difficulties cannot filter out construction noise, traffic, music playing from a window, and other people's conversation to focus on crossing the street, for example.

As well as noise, the smells of the city street can be overwhelming, as can bright sunlight or streetlights or hot or cold weather.[21] Finally, some neurodivergent people described the materials of footpaths – how they are often uneven or one footpath will be made up of many different surface types and textures – as causing sensory overwhelm.[22]

While sensory sensitivities are a common characteristic across different neurodivergent conditions, experiences of these sensitivities differ from person to person. For example, a busy city street can feel overwhelming for some and stimulating for others.[3]

Tools and strategies to mitigate sensory overwhelm

Neurodivergent people utilise many tools and strategies to cope with sensory discomfort when travelling. These include:

- noise cancelling headphones
- sunglasses
- hats
- fidget toys

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- checking layouts of locations online before travel[3,20]
- only travelling at certain times
- avoiding certain places or routes
- only travelling to the same locations, and
- using the same route (down to which side of the street they walk along).[20,21]

Although these strategies can help alleviate sensory distress, they can severely limit neurodivergent people's access to opportunities. Creating travel environments which account for neurodivergent people's sensory difficulties is of utmost importance in addressing the transport accessibility gap.

Design recommendations to mitigate sensory overwhelm

Some literature putting forward design recommendations to ease sensory barriers was from architectural or built environment perspectives,[8,23] while other literature was street design recommendations.[3,9] All the recommendations offer helpful insight into what could enable travel for neurodivergent people.

The first recommendation is to incorporate design features which can control sensory environments. There are already many methods to, for example, control acoustics or lighting which should be incorporated into street design and travel infrastructure design.[23] *Streets for Diversity* advocates for incorporating more greenery into the city, as this can lessen noise pollution and combat some sensory issues brought on by smell by improving air quality.[3] Sensory stations – areas with fidget friendly objectives and other elements like water features and textured walls – are also recommended to enable positive sensory experiences on the journey.[3,23]

The second sensory related design feature is to provide choice wherever possible, due to the diversity in sensory experiences of neurodivergent people.[3,8] Lawburg used the example of a restaurant which provides a quiet area and a loud area, different seating types, and different lighting to enable customers to choose an environment that suits their needs.[8]

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Examples of sensory choices include providing spaces with vibrant street art and areas for music and other artistic creation, and also calming and quiet 'green spaces' (parks, woodlands, community gardens, greenways and so forth) and 'blue spaces' (bodies of water); areas in parks with sunshades or indoor spaces with different lighting; and different seat types in waiting areas.[3,23]

The final recommendation is to provide rest places along the journey.[3,8,9] This can be providing more benches and seats in public spaces but also providing specific retreat spaces, including indoor rest rooms and outdoor quiet places surrounded by calming greenery.[3,8,9]

Wayfinding

Wayfinding refers to, essentially, knowing which way to go, and encompasses following directions, reading maps and following signs, but also being able to intuit where something might be in public space and what the safe route might be through a crowded street, crossing point or around road works.[3,8,21] There are many elements of Wayfinding that many neurodivergent people struggle with, due to difficulties with **Executive functions**.[3,4,8,21] These elements include:

- Understanding sequencing
- Spatial awareness
- Comprehending signs
- Comprehending directions
- Remembering multiple steps/instructions
- Concentration and paying attention.

There are many ways in which street and travel systems are unhelpful in aiding neurodivergent people with wayfinding.[3,4]

Unclear signage

Unhelpful and unclear signs or no signs at all make wayfinding difficult for neurodivergent people, as the following quote from a neurodivergent participant in the *Disabled Citizens' Inquiry* shows:[4]

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> "In Manchester, the backstreets are difficult to navigate because there's not much signage."

27% of disabled people surveyed by Transport for All said that poor signage within stations prevented them from finding correct platforms, lifts and facilities when travelling by train.[15] The barrier of inadequate signage is often exacerbated by not having staff available to ask for help.

Variations in street design

Variations in street design, including crossing designs and cycling infrastructure, also exacerbate wayfinding issues, as each design requires a different set of knowledge of rules and navigation.[3,15,21] Road closures and roadworks require changes of plans and split-second decisions about how to navigate an unfamiliar environment and require added intricacies to journey planning, which is already a struggle.[3,15,21]

Multi-step and multi-modal journeys

Furthermore, journeys often include multiple steps and different transport types, which require knowledge of different transport systems and intricate decision making.[3,15,21] Transport for All's research found that 'interchanging and making connections' was the most difficult part of the journey for disabled people.[15]

Tools and strategies used to mitigate wayfinding issues

Some neurodivergent people report not making journeys at all or turning back half-way when wayfinding becomes too difficult.[8,21] Other neurodivergent people report using taxis to overcome wayfinding struggles, which adds cost to travel that would not be incurred if transport systems were more accessible.[3]

Making wayfinding easier will reduce stress and therefore enable neurodivergent people to travel more and not rely on taxis. Overall, making transport infrastructure and public space as predictable and consistent as possible will help with these barriers to travel faced by neurodivergent people.[9]

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Design recommendations to mitigate wayfinding issues

Strategies put forward in the literature to help with wayfinding specifically come from architecture but are still somewhat applicable to transport.

Neurodivergence and architecture literature underlines the importance of sequencing in helping with wayfinding: areas should be organised logically, based on how people would typically use a space.[8,23] A travel-related example of this could be that bike stands should be placed near the entrance to a building as a person would usually park their bike and then go indoors.

Other recommended strategies include using visual cues to identify main pathways through spaces and, in general, making necessary journey elements (for example, bus stops, crossing places, and cycle paths) easy to identify.[8,23]

Finally, all signs should be neurodivergent-friendly, meaning they use easy-to-read fonts and incorporate symbols as well as words.[8,23]

Physical accessibility of the travel environment

Over 40% of disabled people in the UK often experience problems reaching their destination due to inaccessibility of the environment on a typical walking or wheeling journey.[4] As such, physical accessibility barriers were a clear theme in the pan-disability and travel literature. This is to be expected, as the links between physical disability and/or visual impairments and inaccessibility of the physical environment are very clear. However, neurodivergence also affects physical accessibility barriers to travel and these need to be considered when assessing the relationship between neurodivergence and travel.

Some neurodivergent conditions, such as dyspraxia and autism (described in **Appendix B: brief overview of some neurodivergent conditions**), can affect coordination and

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mobility.[21] Neurodivergence can also be associated with other physical accessibility barriers – for example, autism has been linked with gastro-intestinal issues which require easy access to public toilets.

Navigating inaccessible places and/or infrastructure is frustrating for everyone. For example, finding a safe route around cars parked on pavements is also a burden for neurotypical/non-disabled people. But, as discussed below in the **Travel causes fatigue and stress** section, because of the cumulative effects of all the barriers faced by neurodivergent people as well as fluctuations in energy levels because of neurodivergent conditions, stress thresholds are often lower and decision fatigue is more likely to occur for neurodivergent people. Therefore physical accessibility barriers can feel more burdensome to neurodivergent people compared to neurotypical and non-disabled people.[21]

Examples of physical accessibility barriers

Many physical accessibility barriers for neurodivergent and other disabled people were outlined in the literature. These include:

- Poorly maintained and uneven pavements[3,15,21,22]
- Pavement parking[4,15,21]
- Street clutter, including bins and recycling boxes, café seating, etc.[4,15,21,22]
- Lack of dropped kerbs[4,22,24]
- Overgrown greenery[4,21,24]
- Narrow pavements[3]
- Limited places to rest in public space[3,4]
- Limited public toilets[e] and other public facilities such as water fountains[24,25]
- Reduction of disabled car parking spaces and taxi access due to Low Traffic Neighbourhoods and other car reduction schemes[4,16,26]

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[e] Between 2010 and 2013, local council cuts caused approximately 15% of public toilets to be closed.[25]

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- Cycle infrastructure which is not suitable for adapted bikes[17,18] and
- Barriers and bollards on cycle or mixed use paths.[18]

Other accessibility barriers were identified in pan-disability research:

- Lack of staffing assistance at train stations and public transport hubs[f]
- Inadequate bus stops including lack of seating, lack of shelter
- Inaccessible bus shelters or train stations because of inaccessible surrounding street space and street clutter
- Train stations lacking step free access and level boarding[g][15] and
- Inadequate or unavailable cycling parking for adapted cycles.[17]

Design recommendations to mitigate physical accessibility barriers

Many of the recommendations to combat these barriers are not neurodivergence specific and are outlined in numerous accessibility guidelines and strategies put forward by transport planners.[27,28] However, these guidelines and strategies are inadequately implemented and enforced. In order to address the physical accessibility barriers identified by neurodivergent people, these strategies must be fully implemented to ensure our cities, towns, and travel infrastructure are accessible.

Recommendations to enable the travel environment to be more physically accessible include:

- Improve pavements, including maintaining surrounding greenery
- Eliminate pavement parking
- Reduce or remove street clutter
- Introduce more dropped kerbs

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[f] 56% of stations in the UK are staffed, with only 11% staffed at all times (the other 45% are only staffed part-time).[15]
[g] Around 75% of mainline train stations do not have step free access.[15]

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- Widen pavements and require a minimum width for pavements going forward that would enable people to walk and wheel comfortably
- Ensure there are benches and rest spots in public spaces
- Increase the number of public toilets and other public facilities
- Provide parking close to essential services and traffic free zones
- In traffic-free zones, ensure other transport modes into the area are accessible
- Ensure adequate staffing at public transport stations
- Ensure bus stops have seating and shelter
- Ensure areas around public transport stations are accessible
- Provide step free access and level boardings at all train stations
- Create cycle infrastructure, including cycle parking, that is suitable for adapted bikes
- Remove barriers and bollards on cycle and mixed-use paths.

Personal safety

Fears of harassment, negative comments, or abuse are also a barrier to travel for neurodivergent people identified in the literature.[2,4,8,15,16] According to the *Disabled Citizens' Inquiry* research, 46% of neurodivergent people surveyed feared negative comments when walking and wheeling. This was a similar percentage to the pan-disability figure, which suggests that although some other data is for the overall category disabled people, it may reflect similar patterns for neurodivergent people specifically. The 2021 Walking and Cycling Index (WACI) found that 44% of (overall) disabled people feel unwelcome and uncomfortable when out and about in their neighbourhood compared to 31% of non-disabled people.[4] Personal safety fears limit travel, therefore contributing to the transport accessibility gap and resultant diminished access to opportunities and public life that neurodivergent people face.

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Fears of for personal safety by transport mode

Transport for All surveyed disabled people about their experiences using different transport modes:[15]

- 28% of disabled people were fearful for their personal safety when walking and wheeling
- 12% of disabled people surveyed had experienced a hate crime or anti-social behaviour while cycling
- 22% of disabled people were fearful for their personal safety when using the bus[h]
- 17% of disabled people were fearful of their personal safety when travelling by train.

Personal safety and other personal characteristics

Neurodivergence also intersects with other personal characteristics, creating different experiences of personal safety. Research has found that women are more likely to fear street harassment compared to men.[29] The *Disabled Citizens' Inquiry* found that 37% of disabled women are afraid of negative comments when in public compared to 28% of disabled men, indicating that gender and disability intersect, leading disabled women to be more fearful of street harassment.[4]

Sexuality, transgender and nonbinary identities also intersect with neurodivergence in regard to street harassment. LGBT+ people are more likely to experience street harassment and be fearful of street harassment compared to heterosexual and cisgendered people.[29] Neurodivergent people are more likely to be part of the LGBT+ community. For example, autism is three to six times more common among transgender people compared to the general population and autistic people are less likely to identify as heterosexual compared to neurotypical people.[30] This intersection likely means neurodivergent people are at a greater risk of street harassment and hate crimes than

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[h] 41% of disabled bus users had experienced negative attitudes from bus drivers and 35% had experiences discriminatory behaviour from other passengers.[15]

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neurotypical people, although further research is needed to determine the connections.

Further research is also needed into the relationship between ethnicity, neurodivergence, and street harassment and other safety issues in public space. There is some literature on autism and negative encounters with police, including in intersection with Blackness.[31,32] This may indicate that the intersection between neurodivergent behaviours and Black racial identity is perceived as particularly threatening in white-dominated societies.

Recommendations to mitigate personal safety fears

Fears of personal safety and experiences of violence and harassment because of personal characteristics, such as neurodivergence, gender, sexuality or ethnicity, arguably require deep social change at a systemic level to address. A full exploration of how this kind of change would occur is beyond the bounds of this report.

However, there are many established built environment recommendations to enable feelings of safety for people in public space.[33] These include:

- making sure spaces are well-lit
- ensuring high visibility in all public spaces, and
- ensuring public spaces are well-maintained and often frequented.[33–35]

These infrastructure characteristics are of utmost importance to address safety fears for neurodivergent (and other) people.

Safety from traffic and other people

Fears of motorised traffic and other road users were discussed as barriers to active travel among neurodivergent people in the literature.[4,15,17,18,21,26]

Vulnerability to collisions to other road users

Fears of traffic when walking, wheeling and cycling as well as desires for segregated cycle lanes are common among all active travel users, not just neurodivergent people. However,

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neurodivergent people are often more vulnerable to collisions with other road users (including vehicles) and/or more fearful of collisions because of characteristics stemming from their conditions. Neurodivergent people discussed how their neurodivergence, for example, put them at a higher risk of losing balance when cycling or walking and wheeling or bumping into other road users.[15,21]

Executive functions and road safety

Issues with **Executive functions**, spatial awareness and physical limitations make things like navigating crossing the street especially difficult, something many non-disabled people take for granted. This is true for both designated crossing points and crossing the street at non-designated points.[4,15,21] A participant in the *Disabled Citizens' Inquiry* described the added burden looking for a safe crossing put on their journey:[4]

> "'There also aren't many designated crossing spots, so I end up making extended journeys, looking for safe places to cross.'"

A further element to this barrier, connected to deficits in **Executive functions**, and also discussed in the **Wayfinding** section, is the inconsistency of both infrastructure and other road users' behaviour. This causes confusion, stress and fear for neurodivergent people when walking, wheeling and cycling.[18,21] Kate Ball described her autistic children's experience of navigating the street outside school on their bikes:[18]

> "'It's a fraught and unpredictable environment for everyone outside the protection of motorised metal boxes. Cycling here is a constant stop-start due to hazard avoidance. A hectic space like this is confusing for anyone, but especially for [neurodivergent] children. It can leave them thinking 'are we or aren't we stopping and getting off?'"

The introduction of new active travel infrastructure – especially the Spaces for People and other temporary infrastructure

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projects introduced during the Covid-19 pandemic – exacerbated the issue of unpredictability and variance in infrastructure design for neurodivergent people.[26] Each scheme was different, having different rules and safety considerations, which caused confusion and decision fatigue for neurodivergent travellers.

Design recommendations to address safety fears

As with the barriers around physical accessibility and personal safety fears, there are many established examples of good practice among transport planners to address safety fears of traffic or other road users.[27,28] These include:

- Separating transport modes to provide more space on the pavement for people walking and wheeling
- Protecting cyclists from motor traffic through segregated cycle lanes
- Introducing more frequent designated crossings designed with disabled people, including neurodivergent people, in mind, with adequate, neurodivergent friendly signage, dropped kerbs and other accessibility features
- Consistent infrastructure and limiting design variations to help with decision fatigue and safety concerns over not knowing correct ways to navigate each individual cycle scheme or other travel system.

Transport poverty

Transport poverty refers to 'households and individuals who struggle or are unable to make the journeys that they need' because of financial constraints.[36] Disability, including neurodivergence, is associated with transport poverty.[4] The majority of the literature on transport poverty comes from a pan-disability perspective, and further research is needed to establish the connections between neurodivergence and transport poverty in particular.

Poverty and disability

The reasons for the connections between disability and transport poverty are manifold. The barriers many disabled

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people face to travel – as discussed through this literature review – results in the transport accessibility gap. The transport accessibility gap limits education and employment opportunities for disabled people: a quarter of disabled people report inaccessible transport as the reason for their unemployment.[37]

As well as inability to travel, disabled people face many other barriers to education and employment relating to their conditions and the barriers present in society. As such, the disability employment gap (the difference in employment rates between disabled and non-disabled people) in the UK is around 28%.[4]

There is high unemployment among neurodivergent people in particular: just over one fifth of diagnosed autistic adults are employed, and upwards of 60% of people with ADHD have felt they have lost a job due to their neurological conditions.[38]

These high unemployment rates result in many disabled people living in poverty, and therefore experiencing transport poverty. Furthermore, the cost of living crisis has exacerbated this issue, with almost 60% of disabled people reporting they have reduced the amount they travel due to rising costs.[4]

Cost associated with disability

As well as being more likely to live in poverty compared to non-disabled people, it is expensive to be disabled. Life costs an average of almost £600 per month more for disabled people compared to non-disabled people.[4] As part of this, travel can be more expensive for disabled people, due to the cost of mobility aids, vehicle adaptations, tickets for carers or support workers, reliance on taxis and so forth.[3,37] 25% of Transport for All's survey respondents reported they would cycle but cannot afford an appropriate bike, as many disabled people require adapted cycles or cycles with a pilot, which can be very expensive.[15]

These are pan-disability statistics, so it is not clear how much more expensive neurodivergent people find living or travel compared to the general population. There is some awareness

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that neurodivergent people experience economic disadvantage, such as with the concept of the 'ADHD tax: 'the price you pay for costly mistakes due to symptoms of ADHD.'[39–41] In travel, an example of these costly mistakes could be missing public transport trips and incurring higher fees for replacement or flexible fares.

Tools and strategies to mitigate transport poverty

Disabled people already respond to transport poverty by reducing the amount they travel. This, however, results in the transport accessibility gap which limits disabled people's lives immensely, and is therefore not an equitable solution to transport poverty. Other solutions could include the introduction of more funding for neurodivergent and other disabled people's transport as well as expansion of existing schemes which often do not cover neurodivergence, such as the Disabled Person's Railcard and the Motability scheme.

Policies and systemic change required to remove transport poverty

However, to adequately address transport poverty among neurodivergent and other disabled people, wider societal change is needed, including removing the barriers neurodivergent people currently face to education and employment, and providing public welfare for neurodivergent people not in work to enable them to live flourishing lives.

Furthermore, towns and cities need to be redesigned to enable everyone to be able to walk, wheel, or cycle where they need to go, and therefore reducing the reliance on costly transport modes. 88% of respondents to the *Disabled Citizens' Inquiry* survey said a planning system which ensured essential services were within walking and wheeling distance would be useful for them to walk or wheel more.[4]

Barriers to decision-making

Currently, transport systems, towns and cities are typically planned by and designed for non-disabled and neurotypical people, and the needs of neurodivergent people are often

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overlooked.[4,21] This is reflective of inaccessible community engagement processes and barriers to avenues of power faced by neurodivergent people, including the employment gap.

This problem is somewhat cyclical, as, for example, the built environment is inaccessible, which prevents neurodivergent people from using transport modes and accessing avenues to input into creating the built environment, and therefore the built environment continues to be inaccessible. WACI found that 35% of disabled people feel able to participate in making their neighbourhoods a better place, compared to 45% of non-disabled people.[4]

Once again, most of the literature on this issue comes from a pan-disability perspective, so further research is required to ascertain the role of neurodivergence in these structural barriers to avenues of power and decision-making.

Cycling policies

The literature outlined how the lack of disabled people in positions of power and planning positions, alongside the lack of visibility of disabled cyclists, could be leading to people believing disabled people cannot cycle, and therefore planning cycling systems that do not take into account the needs of disabled cyclists.[15,19]

Andrews et al.'s analysis of Transport for London policy and strategy documents found that disabled people were largely conceptualised as public transport users or pedestrians, not cyclists.[19] Where disabled cyclists were included, the policies were often limited to general aspirations or references to leisure cycling clubs and training.[19]

There appears to be a pervasive view that disabled people do not cycle. Transport for All found that 18% of disabled people were impacted by the belief that disabled people cannot cycle.[15] Transport for All went on to summarise:

"'If held by decision makers, these attitudes can reinforce the physical barriers we face. If disabled people are believed to be inherently unable to cycle, accessible cycles and

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Low Traffic Neighbourhoods

Low Traffic Neighbourhoods (LTNs), and similar infrastructure schemes aimed at reducing/removing cars, are another area where lack of involvement by disabled people results in barriers to travel. LTNs use tools such as bollards, barriers and cameras to remove motorised through traffic on certain roads, diverting it to other distributor roads, with the aims of encouraging walking, wheeling and cycling, reducing pollution, and reducing road danger.[42]

LTNs have proved to be very controversial, both across society as a whole, for various reasons, and within the disabled community because of negative impacts on, and lack of consideration of, disabled people.[26,43] Overall, according to Transport for All's *Pave the Way* report, which surveyed and interviewed disabled people on their views on LTNs, disabled people felt they were not consulted nor listened to in regard to LTNs.[26] 72% of participants in this research reported issues with how changes have been communicated, including the lack of information provided, its quality or accessibility, and not receiving a warning before an LTN was installed.[26]

This was especially the case as many LTNs were introduced as emergency social distancing measures during Covid-19 and therefore did not have thorough consultation processes.[26,42] Furthermore, as many disabled people were shielding during Covid 19, they could not engage in the consultancy processes that did occur.

Disabled people felt others spoke on behalf of them for their own political gains.[26,42,43] People who held positive views on LTNs claimed that they were positive for disabled people as they enabled them to walk and wheel more safely. People who held negative views claimed they were negative for disabled people as they caused disabled people to be stuck in traffic for hours due to the traffic diversion and blocked them from

accessing essential services due to street closures and removal of parking spaces.

However, according to multiple research projects on LTNs, disabled people held both positive and negative views on LTNs.[26,42,43] Many disabled people reported easier, more pleasant and more independent journeys as a result of the LTNs, as well as a decrease in traffic danger – this contributed to overall benefits in mental and physical health.[26,42,43] However, journey times were longer and support workers and carers had greater difficulty accessing disabled people's homes. This led to travel becoming more exhausting, expensive and complicated.[26,42,43]

Neurodivergent people reported in other research that they found the variety, inconsistency and lack of warning about LTNs especially difficult to cope with.[3,20]

Disabled people did not want LTNs to be simply removed and the status quo returned, as what was there before was also not accessible. Furthermore, many do wish to walk, wheel and cycle more, but they want infrastructure which fully removes barriers to active travel, which LTNs do not achieve.[26,42,43]

Strategies to enable avenues to decision making for disabled people

A necessary part of solving many of the barriers outlined in this literature review, and better enabling active travel, is to give neurodivergent people a role in decision making processes, especially regarding decisions that impact them. Disabled people want to be given opportunities to input into decision making, to be listened to, and to not be spoken for in regard to transport planning and infrastructure design, as well as other spheres.[26] This relates to the disability rights philosophy of Nothing About Us Without Us.

Small tweaks to consultation processes to make them more accessible (such as providing consultation information in a variety of formats and providing a variety of avenues for feedback) and specific targeting of consultation processes to neurodivergent people would be useful. However, in order to

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make our society more accessible to neurodivergent people, neurodivergent people need to be meaningfully involved at all levels.

The *Disabled Citizens' Inquiry* recommended disabled citizens transport advisory panels, which would enable disabled (including neurodivergent) voices to be listened to in transport planning processes.[4]

Travel causes fatigue and stress

Overall, because of the barriers they face, most public spaces and most journeys cause stress, anxiety, and fatigue for neurodivergent people.[3,8,18,20,21] Neurodivergent people's neurological differences mean they process information differently, communicate differently, and process the sensory environment differently compared to neurotypical people: design of travel systems and public space inadequately take into account these differences. This means travel and public space can often lead to sensory overload and overwhelm, as well as being a generally tiring experience having to navigate the numerous barriers they encounter.

A further cause of fatigue is caused by being in public space generally, because many neurodivergent people hide or 'mask' their neurodivergence to avoid appearing different and minimise risk of harassment (described in **Masking**).[2,8] As noted below, masking takes considerable energy.

Furthermore, because public space can be so stressful to navigate, some neurodivergent people experience meltdowns or panic attacks: participants in various studies told stories of panic attacks on buses or crying in alleyways after becoming overwhelmed on their journeys.[3,20] Fear of meltdowns and panic attacks also stops people from travelling.

Intricate planning to avoid discomfort

In order to limit discomfort and avoid barriers faced during their journeys, many neurodivergent people spend a lot of time and energy planning their journeys.[3,44] However, this in itself causes stress, anxiety and fatigue as the planning often has to be very

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detailed, taking into account not only the intricacies of the various elements of the journey – for example, lining up arrivals and departures of buses – but also physical accessibility barriers, the sensory environment, crowds, and the many other factors which make travel unbearable if not anticipated and planned for.[3,15,44] A neurodivergent participant in Kenna's study explained:[20]

> "'It's planned to a tee when I go in [to the city] … I generally won't go somewhere unless I know exactly what I am doing and for how long."

Transport for All's research into journey planning found that 45% of disabled people said they cannot travel spontaneously and need to have a plan.[45]

The time-consuming and stressful process of travel planning for neurodivergent and other disabled people needs to be considered as an accessibility barrier in itself.[44] Some neurodivergent people reported journey planning was so tiring that they did not then have the energy to go out.[3]

Accessing necessary journey planning information

An added complexity to journey planning is that the information required is often inaccurate, difficult to find and/or inaccessible.[20,44,45] The information neurodivergent people need but often cannot find includes:

- Walking distances within train stations, public transport hubs or other public spaces
- Availability and working status of lifts and escalators in public spaces
- Staffing levels especially at transport hubs, but also other locations
- Crowding levels in public spaces
- Availability/location of toilets, accessible toilets, changing places, rest stops in public spaces
- Whether priority spaces/seats(s) are occupied on public transport or other places.[45]

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When information is provided, it is often not in accessible formats. For example, information conveyed through posters, departure boards or Tannoy announcements can be difficult to take in for neurodivergent people, depending on their sensory or executive functioning differences.[45]

Finally, information provided is not always accurate: a recent study found a third of disabled people have been given inaccurate information regarding the accessibility of a mode of transport or a station.[44]

Exhausting journeys

Even with intricate planning, journeys are still exhausting. Sometimes, in order to make a journey accessible, it is longer and more complex than it would be for someone not navigating these accessibility issues Moreover, intricate journey planning cannot control for the unpredictability of public space and travel. Many neurodivergent people find it difficult to quickly adapt to changes, and experience overwhelm and decision fatigue at all the choices necessary to navigate the journey, from a late bus changing the journey plan to unexpected crowds to loud construction noises.[3,20]

A participant from Transport for All's research explained the impact travel has on her mental health that non-disabled and neurotypical people do not have to navigate:[15]

"'It causes me undue stress. The stress of planning, of booking access, of the discrimination and distress when things go wrong on the journey, and having to complain about it afterwards and take action, means they take up an inordinate amount of my time, energy, mental health and executive function."

Tools and strategies used to mitigate fatigue

Neurodivergent people use a variety of strategies to combat the stress and fatigue associated with travel and being in public space. This includes intricate journey planning, as discussed above under **Intricate planning to avoid discomfort**. The

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Tools and strategies to mitigate sensory overwhelm
outlined above are also used to mitigate stress and fatigue.

Implementation of other tools and strategies could also alleviate this barrier to active travel and other travel. These include promoting and further developing journey planning tools which are accurate, accessible, and provide data useful for neurodivergent people to navigate public space.

Further implementation of initiatives such as 'please offer me a seat' badges on public transport, quiet shopping hours, sensory friendly cinema nights, and hidden disability lanyards, would also provide more safe spaces for neurodivergent people while traveling and in public space generally.[3,9]

However, systemic change to transport systems and the built environment is required to make public space accessible and life-giving for neurodivergent people, instead of another area that drains energy and causes fatigue, stress and overwhelm.

Policy

There is currently limited policy relating specifically to neurodivergence and active travel in Scotland or the UK. For example, the Scottish National Transport Strategy does not mention neurodivergence.[46]

There are policy, strategy and guidance documents from the UK government and devolved governments aimed at reducing accessibility barriers to transport for disabled people and increasing transport options. For example, the Scottish National Transport Strategy[46] and Transport Scotland's Active Travel Framework[47] both explicitly set priorities relating to increasing travel for disabled people, reducing barriers, increasing accessibility and reducing social isolation. The Scottish Government's 2023 consultation paper on the Learning Disabilities, Autism, and Neurodivergence Bill has a section on transport that may produce more policy relevant to this topic, but the consultation document focuses almost entirely on public transport. Wayfinding, inclusive street design,

and accessible pavements are mentioned in relation to traveling to public transport.[48]

Other policies relating to increasing accessibility for disabled people across the UK include:

- National Disability Strategy 2021[49]
- Inclusive Transport Strategy 2018[50]
- Inclusive Mobility A Guide to Best Practice on Access to Pedestrian and Transport Infrastructure 2021[51]
- Cycling By Design[52]
- LTN 1/20 (Cycle infrastructure Design)[53]
- Bus Back Better 2021[54]
- Equality Act 2010[55]

In addition to these various policies and strategies, the UK-government and devolved governments also have advisory groups of disabled people to provide advice on the needs of disabled people in relation to travel. In Scotland, the group is called the Mobility and Access Committee Scotland (MACS).[56]

It must be noted, however, that these various groups, policies and strategies are from a pan-disability perspective and do not explicitly address the specific travel needs of neurodivergent people. There is government policy relating to autistic people, including the Autism Act 2009[57] (although this doesn't apply in Scotland) and the Scottish Strategy for Autism.[58] These policies do not relate specifically to travel, instead setting out strategies and legislative guidelines on how governments can support autistic people in all areas of their lives.

At a Local Authority Level in Scotland, there is also little to no specific policy and guidance around neurodivergence and travel. Many Local Authorities have autism strategies, as required by the Autism Act, although these often relate to educational support or independent living support, rather than travel. Local Authorities often do have disability policy and guidance, as well as specific support for disabled people's travel through the 'Blue Badge' programme, disabled parking requirements, assistance with public transport costs, and accessibility requirements for infrastructure design.

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Furthermore, many have disability advisory groups and access committees, similar to MACS.

Overall, it is clear that development of policy, strategy and guidance to support neurodivergent people's travel is required. However, as limited research currently exists which specifically identifies neurodivergent people's travel needs, the first step in this process must be targeted and meaningful engagement with neurodivergent people, to better understand their needs in relation to travel systems, the barriers they currently experience, and the strategies that will enable their use of active travel.

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Appendix A: key terms and definitions

Social model of disability

The neurodiversity paradigm used in this report are underpinned by the *social model of disability*.[10] This model or way of understanding disability focuses on disablement caused by barriers and inaccessibility of society, as compared to the dominant medical model that focuses on disablement caused by impairment or difference.[4]

This model acknowledges that people have differences and impairments, but does not consider that a person's disability is simply a natural result of these impairments and differences.[59,60] Rather, disability arises from those differences or impairments in interaction with societies that can be more accessible or less accessible to people with those differences or impairments.[59,60] For example, it is not a wheelchair user's physical difference that is stopping them from accessing the second storey of a building, but the lack of a lift.

This model seeks to identify aspects of society that disable, for example, Deaf, Down syndrome, or dyslexic people from full participation, and to reduce these barriers to make society more accessible and less disabling. Therefore, for example, travel infrastructure and systems should be designed with attention to eliminating barriers for people with particular impairments or differences.[4]

Together, the social model and the neurodiversity paradigm suggest that – for example – autism is a difference, not a disease or a disability, but, nonetheless, autistic people are disabled as societies are set up in ways that disable autistic people. Many attributes that are considered deficits of neurodivergent people are actually just natural variations, and are only viewed as deficits if neurotypicality is considered the only correct way minds should function.

Neurotypical

Neurotypical is a term developed alongside 'neurodiversity' and 'neurodivergent' as part of the neurodiversity paradigm to describe people who do not have a neurological condition – essentially people who are not neurodivergent.[1,61] People who are neurotypical could be seen to have a 'normal' or 'standard' brain; their brain functions are not impacted by neurodivergent conditions.[61] Other terms refer to people who do not have a specific neurodivergent condition (but may have others), such as 'allistic' or 'non-autistic' for people who are not autistic.

Executive functions

Executive functions is an umbrella term that encompasses a wide range of abilities or brain functions necessary to set, execute and complete tasks.[62,63] What is and is not considered an executive function varies, but some examples include:

- working memory,
- inhibitory control,
- planning,
- reasoning,
- self-awareness,
- self-regulation and
- problem solving.[62,63]

Difficulties with executive functions can lead to disorganisation, mood swings, struggles with task initiation and multitasking, issues with processing, storing or retrieving information, and difficulties with changing plans or switching tasks.[64]

Neurodivergent people can struggle with various executive functions – this can sometimes be referred to as experiencing executive dysfunction, having executive function disorder, or struggling with 'executive functioning'.[62,63]

Finding various executive functions challenging can impact travel planning and how neurodivergent people experience their journey.

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Masking

Masking is a term for when neurodivergent people seek to limit expressions and behaviours that make their neurodivergence visible, instead seek to act in ways that appear neurotypical.[8,65] Masking can include performing actions that the person may feel uncomfortable with, such as eye contact. It can also include suppressing actions, such as stopping oneself from stimming (repetitive movements or other behaviours to regulate feelings, common among many neurodivergent people) or holding back from expressing true feelings.

Although masking is closely associated with autism, masking is experienced by most neurodivergent people.[8] Masking can be a spontaneous coping mechanism or something that neurodivergent people have been trained to do in some 'treatments' aimed at suppressing neurodivergence.[8,65] Masking is motivated by the feeling that fully being oneself as a neurodivergent person is unsafe or will incur negative social consequences, or that it is inherently pathological.[66,67] Some neurodivergent people avoid participating in conversation or activities altogether if they do not feel they could successfully mask while doing so.[65–67]

Masking is known to lead to depression, anxiety, burn out and other negative health consequences. [65–67] The literature suggests this is partly because neurodivergent people experience better mental health when accepting their neurodivergent identity and traits. Masking, which is seeking to suppress or hide those traits, can negatively impact on this self-acceptance. Another contributing factor to negative health consequences is that masking expends considerable amounts of energy, which is a scarce resource for many neurodivergent people (see **Spoons**).

Masking as a strategy is, at most, only partially successful in helping neurodivergent people pass as 'normal'.[65–67] More importantly, it does not remove the underlying problem of neurodivergent people not feeling accepted as their true selves. This underlying problem can only be solved by making society more accepting of diverse neurotypes and their

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expression. This will also reduce the perceived need for masking.

Double empathy

The concept of 'double empathy' or the 'double empathy problem' originated in the autistic activist community as a response to the pervasive belief that autistic people are not empathetic, and the subsequent harmful 'treatments' prescribed to autistic people to deal with this.[68]

While it is true that autistic people struggle with social interactions, proponents of double empathy surmise that these issues are not a problem with autistic people but instead a result of both **Neurotypical** people and autistic people not understanding each other because of their neurodiversity.[68] Essentially, autistic people do not lack empathy any more than neurotypical people lack empathy: it is that both sides have difficulties understanding each other because their brains work differently.

Double empathy extends further than just differences between autistic and non-autistic people but applies to all neurodiversity. It reinforces the need for a diversity of voices inputting into transport planning. If there are – for example – no people with ADHD involved in decision-making, those who are involved will not naturally empathise with ADHD people and recognise their transport needs.

Spoons

The spoons theory is an analogy developed by people with chronic illnesses and/or disabilities and/or neurodivergent conditions to explain how differences in energy-levels impact people's day-to-day lives.[69]

Using this analogy, a 'spoon' represents a unit of energy and the tasks of everyday life require units of energy/spoons. Everyone has a finite number of spoons for the day, but disabled people (including neurodivergent people) often find they have fewer spoons and/or that tasks take a higher proportion of their daily spoons than non-disabled people. For

example, a trip to the supermarket for a non-disabled and neurotypical person may take three spoons, but for someone who struggles with executive functioning and sensory overwhelm, it could take ten spoons and result in the person not having enough spoons to complete the rest of the day's tasks. Although some people do quantify their spoons count, most do not, but use the term as a general metaphor to describe the complexity of negotiating the energy required to complete day-to-day tasks when living as a disabled person.

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Appendix B: brief overview of some neurodivergent conditions

Autism

Stephen Shore[70] defines autism as 'a non-standard way of perceiving, processing, and interacting with the world.' As a result autistic individuals often express themselves by communicating and socially interacting differently than non autistic people. There are many characteristics associated with autism[71–73], including:

- independent thinking including heightened attention to certain details and patterns and lessened attention to others;
- intense interest in certain topics or 'special interests' and an ability to hyperfocus;
- differences and difficulties with executive functions;
- repetitive behaviour, including stimming[i];
- preferring the consistency and predictability of routines;
- higher or lower than average sensitivity to various sensory phenomena, which often leads to sensory issues (discussed further in **Sensory Processing Disorder**);
- differences in social interactions, including attention to direct or literal meaning more than unwritten social rules;
- language and communication differences, sometimes including lack of verbal communication.

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[i] Stimming refers to repetitive movements or other behaviours to regulate feelings. It is common among many neurodivergent people.

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Autistic adults or children often have a 'spiky profile,' performing better than average in some areas but worse than average in others – for example, excelling in their professional field while struggling with household tasks.[71,74]

As well as a wide range of autistic characteristics, the way people experience them differs immensely – as illustrated in Figure 1. Furthermore, there is a significant amount of misinformation about autism, stemming from research into autism done by non-autistic people which has resulted in ableist and inaccurate conclusions about autism, as well as unhelpful pop culture depictions of autistic people.[67] This diversity of experience and misinformation inhibit autism diagnosis rates among girls and women, ethnic minorities and other marginalised groups.[67,75,76]
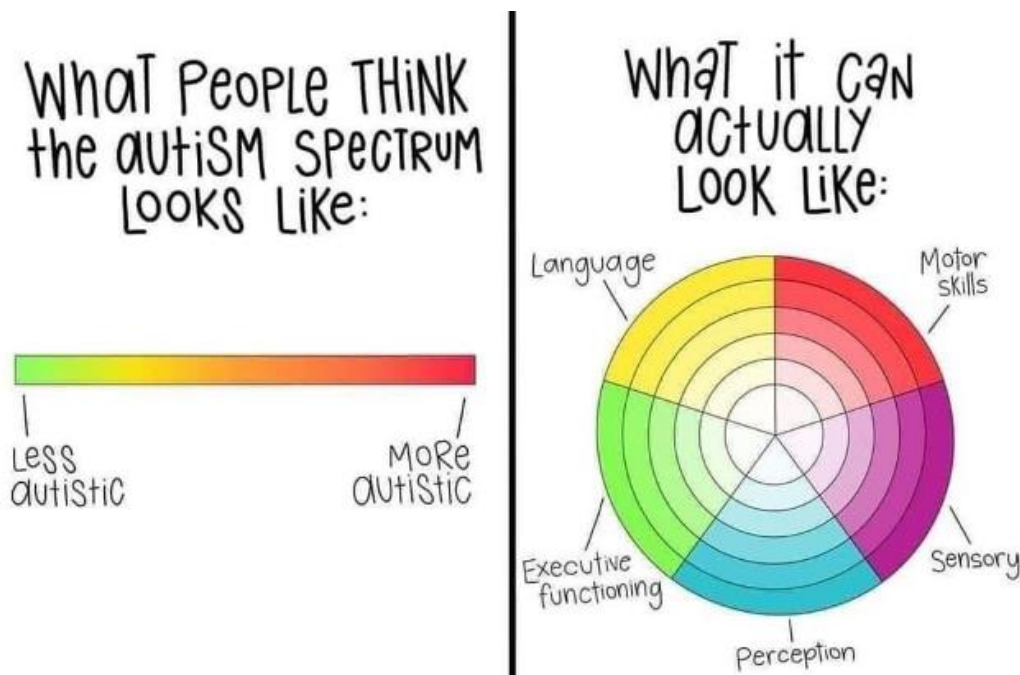

Figure 1: Depiction of the Autism Spectrum[71]

Autism is sometimes called Autism Spectrum Disorder or ASD. However, in line with the neurodiversity paradigm being used in this literature review, conceptualising and describing

neurodivergences as 'disorders' should be avoided when possible.

Attention Deficit Hyperactivity Disorder (ADHD)

ADHD is a neurological condition which impacts people's **Executive functions**.[77] ADHD has been thought of as a learning disability, behaviour disorder, or mental illness, but it is better understood as a 'neurodevelopmental condition' caused by developmental difference,[78] or alternatively a 'development impairment of the brain's self-management system'.[77] People with ADHD can struggle in many areas, including (but not limited to):

- planning and organisation;
- focus – either because they cannot focus or because they become hyperfocused to the detriment of the completion of necessary daily tasks;
- impulsivity;
- hyperactivity; and
- intense emotions.

Traits associated with ADHD can also be 'channelled as strengths' which can bring advantages in work, relationships, and other areas of life. These include hyperfocus, creative and flexible thinking, the ability to be spontaneous, and in some cases high energy.[79] People with ADHD, like autistic people, often have 'spiky' skills profiles.[74]

There are considered to be three subtypes of ADHD – inattentive, hyperactive or combined. The characteristics experienced by individuals vary by which subtype of ADHD they have, as well as many other factors. As with autism, the diversity of experience as well as pervasive stereotypes have led to popular misunderstandings of ADHD and lower diagnosis rates among marginalised groups.[77]

As indicated by the standard name, ADHD currently tends to be defined in negative terms ('disorder', 'deficit') with focus on difficulties experienced, low points on the spiky profile, and

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variation understood as pathology. Particularly criticised is the suggestion of an 'attention deficit,' which does not capture experiences of hyperfocus. A suggested alternative is to say people of this neurominority 'distribute their attention differently.'[80] Some thinkers such as Nick Walker propose alternative languages for this neurodivergence such as 'kinetic cognitive style,' thought to better describe 'a cognitive style driven by attention, interest, fascination, novelty, challenge, and urgency.'[81]

Dyspraxia

Dyspraxia (sometimes called Developmental Coordination Disorder or DCD) is a condition which primarily affects movement and coordination, but also impacts on organisation and planning skills and speech and language.[82] Once again, the characteristics and experiences of dyspraxia differ from person-to-person. Some common characteristics include:

- Difficulty in carrying out movements that others find easy;
- Poor spatial awareness;
- Difficulty learning new movements or transferring motor skills from one task to another;
- Struggles with planning and organisation;
- Forgetfulness or poor working memory; and
- Difficulties participating in conversations – this could be a result of verbal dyspraxia, which leads to struggles coordinating the physical movements required for speech.[82]

Dyspraxia and Sensory Processing Disorder, described below, are typically understood as disorders. It is possible that thinkers using the neurodiversity paradigm and social model of disability will develop alternative understandings of these neurodivergences, as has been seen for autism or, to a lesser extent, ADHD. Potentially, future conceptualisations will be more neutral rather than deficit-based, and will interpret the difficulties associated with these disorders as resulting from societal disablement of minority neurological styles.

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Sensory Processing Disorder

Sensory Processing Disorder (SPD) is a neurological condition which impacts the body's ability to process and respond to sensory information (sight, sound, touch, smell and taste).[83] People with SPD can often become overwhelmed and overstimulated, as they are perhaps unable to filter out background noise or are particularly sensitive to bright lights or strong smells.[83] Many people find loud competing conversations or a flickering light distracting, but people with SPD can find them unbearable. SPD is often concurrent or a part of many other neurodivergent conditions, such as ADHD or autism.[83]

Highly Sensitive Person (HSP) is a developing psychological category which is closely related to SPD.[84] As with SPD, people who identify as an HSP are extremely sensitive to their physical environment, but are also extremely sensitive emotional and social stimuli.

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