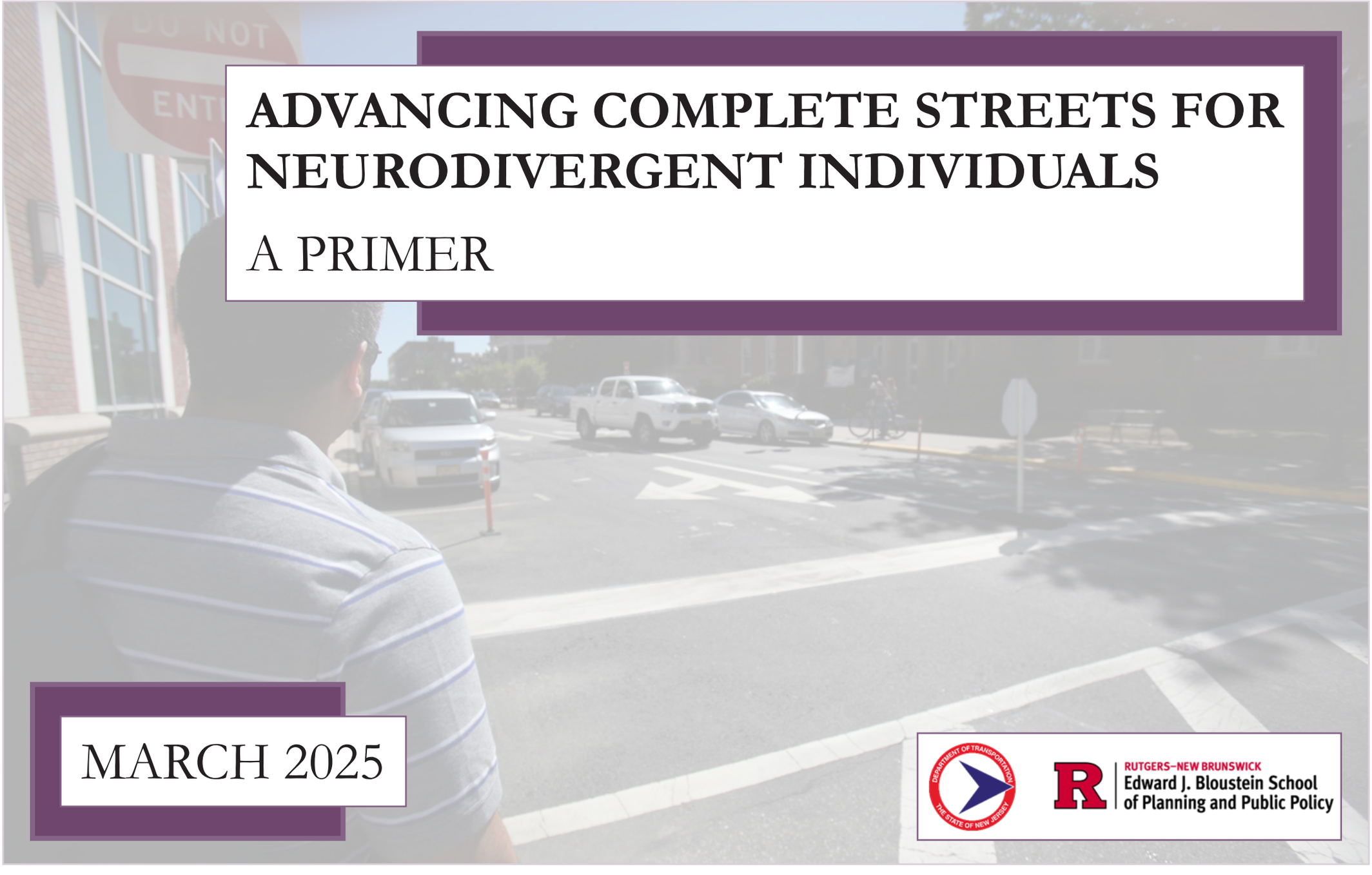

ADVANCING COMPLETE STREETS FOR NEURODIVERGENT INDIVIDUALS

A PRIMER

MARCH 2025

RUTGERS–NEW BRUNSWICK
Edward J. Bloustein School of Planning and Public Policy

Acknowledgments

The Alan M. Voorhees Transportation Center (VTC), supported by the New Jersey Department of Transportation, is a national leader in the research and development of innovative transportation policy. Located within the Edward J. Bloustein School of Planning and Public Policy at Rutgers, the Center brings to bear the full array of resources of a major research university on transportation issues of regional and national significance.

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This primer is dedicated to the memory of Dr. Cecilia Feeley, whose groundbreaking work inspired New Jersey to become the first state to mandate Complete Streets for neurodivergent people.

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INTRODUCTION

Introduction

The purpose of this primer is to add to existing knowledge on the topic of transportation patterns and barriers as experienced by people with autism spectrum disorder (ASD) and/or intellectual and developmental disabilities (IDDs).[1] The primer includes background information on New Jersey's 2023 legislation addressing Complete Streets for neurodivergent individuals, a glossary of relevant terms, and key findings on how ASD and IDD diagnoses can impact walking, bicycling, and access to transit. Since only a small percentage of New Jersey adults with ASD drive (about 3%), discussion on driving is limited.[2] This primer is not exhaustive and is intended to provide an overview of the challenges faced by many individuals with ASD and IDDs as well as opportunities to improve active travel for neurodivergent persons.

The key findings in this primer were synthesized from a review of literature from reputable institutional outlets, published books, and peer-reviewed scholarly articles. A full list of sources can be found in the Appendix. Findings were also obtained from eight subject matter expert interview sessions, which focused on gathering information on characteristics associated with neurodivergence that can make walking, bicycling, and accessing transit challenging, as well as potential design features that could make traveling by foot, bicycle, or transit in New Jersey safer and more inclusive for neurodivergent people. More information on interview subjects can be found in the Methodology section.

The Legislation

In January 2023, New Jersey Governor Phil Murphy signed NJ Bill S-147 into law, directing the New Jersey Department of Transportation (NJDOT) to implement a Complete Streets Policy that "improves safety for persons diagnosed with autism spectrum disorder (ASD) and persons with intellectual and/or developmental disabilities (IDDs)." The legislation also directs NJDOT to develop universal design concepts that advance the mobility options for individuals with IDDs, as well as develop guidance and policies for how the design concepts shall be incorporated into the planning, design, construction, maintenance, and operation of new and rehabilitated public highways and public transportation projects. The law also requires that NJDOT encourage regional and local entities that apply for funding through the local aid program to adopt a Complete Streets policy that complies with the new legislation.

Following the passage of the S-147 legislation (Complete Streets for People with ASD and IDD) in January 2023, New Jersey adopted sister bill S-146 in November 2023. S-146 requires the Bureau of Research, Innovation & Information Transfer within NJDOT to "consider the transportation and mobility needs of New Jersey residents with physical, sensory, intellectual, and developmental disabilities." Together, these two laws aim to ensure that New Jersey's transportation system is designed to support the mobility and safety of all who use it, including those with ASD and IDDs.

This legislation was inspired by a 2015 report titled *Detour to the Right Place: A Study with Recommendations for Addressing the Transportation Needs and Barriers of Adults on the Autism Spectrum in New Jersey*, which Dr. Cecilia Feeley from the Rutgers Center for Advanced Infrastructure and Transportation (CAIT), co-authored with Dr. Deva Deka and Andrea Lubin from the Alan M. Voorhees Transportation Center (VTC), and Melanie McGackin from Autism Family Services of New Jersey. The study focused on gaining insights into the transportation barriers experienced by New Jersey adults with autism, identifying characteristics and traits commonly experienced by adults with autism, and their impact on transportation choices, employment opportunities, community involvement, and overall quality of life.

Stemming from a recommendation included in the 2015 report, the state established the New Jersey Task Force on Transportation, Mobility, and Support Service Needs of Adults with Autism. The Task Force, which Dr. Feeley chaired, was tasked with identifying state policies and programs that can be improved to help remove or lessen barriers and enhance access to transportation and secondary support services for people with autism and intellectual and/or developmental disabilities. The Task Force produced a 2021 report recommending that the transportation needs of persons with autism be considered when designing Complete Streets. The report also noted that environmental barriers that inhibit access to transit stops are a significant concern

for persons with ASD and their families and identified a need for additional research focused on determining autism-friendly infrastructure improvements to the built environment.

In addition to producing the two aforementioned reports, Rutgers, The State University of New Jersey, has focused on neurodivergent individuals through initiatives such as the *Rutgers Center for Autism Research, Education, and Services (RUCARES)*, the *Edward J. Bloustein School of Planning and Public Policy's Disability Studies minor*, and collaboration with the *New Jersey Autism Center of Excellence (NJACE).*

Civil Rights

NJ Bills S-146 and S-147 (Complete Streets for People with ASD and IDD) represent a milestone for advancing equitable mobility in New Jersey that might have been impossible without the Americans with Disabilities Act (ADA). Passed in 1990 and last amended by Congress in 2008, the ADA is a civil rights law that prohibits the discrimination of people based on disability and has led to improvements in the built environment that have increased access to the public domain for people with disabilities. The ADA protects those with disabilities, which are defined as individuals with a physical or mental impairment that substantially limits major life activities, individuals with a history or record of impairment, and individuals who are regarded as having an impairment by others even if they do not have an actual disability. Disabilities include both physiological and mental conditions, including intellectual disabilities, organic brain syndrome, emotional or mental illness, and specific learning disabilities. Major life activities are defined as basic activities that most people can perform with little or no difficulty, such as eating, sleeping, walking, thinking, reading, or speaking. Under the ADA, a disability does not have to completely or severely limit a major life activity to be considered substantially limiting.[3]

> The ADA is written to protect a broad group of individuals, including those with physical and/or mental disabilities that substantially limit major life activities, such as eating, sleeping, walking, thinking, reading, or speaking. The ADA also protects those who are regarded as having an impairment by others even if they do not have an actual disability.

Figure 1. Civil rights demonstrators march in support of ADA. "Nothing about us, without us!" has been a common declaration of civil rights groups that emphasizes their desire not to be governed by a non-representative body. (disabilityphilanthropy.org)

While the ADA lists both physical and mental disabilities as protected classes and holds that the definition of disability "shall be construed in favor of broad coverage of individuals," many of the resulting design concepts have focused on people with physical

impairments.[4] For example, curb cuts and elevators are standard design features that improve access to a location for people who utilize mobility devices, such as wheelchairs. However, design concepts that support neurodiverse persons are not as well documented or understood.

The ADA requires state and local governments, including state Departments of Transportation, to develop ADA Transition Plans that outline a process for eliminating physical barriers to accessibility in transportation systems and facilities.[5] During assessments, specific barriers such as physical obstacles (e.g., lack of ramps or accessible signals), communication barriers (e.g., no accessible formats for information), or policy barriers (e.g., discriminatory practices) are identified. Once barriers are identified, they are prioritized based on factors like the impact on accessibility, the number of people affected, and the cost and feasibility of removal or modification. ADA Transition Plans are reviewed and updated periodically to reflect changes in laws, advancements in accessibility standards, and feedback from stakeholders.

NJ Bills S-146 and S-147 (Complete Streets for People with ASD and IDD) represent more than a transportation safety initiative; they are civil rights laws. The two bills signify an intention to enhance the built environment so that neurodiverse people are not passively discriminated against through unaccommodating design and are afforded similar transportation opportunities as all persons.

Design Guides

In response to legislation like the Americans with Disabilities Act of 1990 (ADA) and the Architectural Barriers Act of 1968 (ABA), the U.S. Access Board has published Public Right-of-Way Accessibility Guidelines (PROWAG). The guidelines contain technical requirements to ensure that pedestrian facilities located in the public right-of-way are accessible to pedestrians with disabilities.[6] PROWAG applies only to newly constructed pedestrian facilities or altered portions of existing pedestrian facilities and addresses access to sidewalks and streets, crosswalks, curb ramps, pedestrian signals, on-street parking, and other components of public right-of-way. The guidelines were released in August 2023.

Figure 2. An intersection with pedestrian visibility enhancements and painted bike lanes. (NJDOT Bicycle and Pedestrian Resource Center)

Figure 3. Many members of the neurodivergent community cannot drive and/or reside in neighborhoods where walking and transit are impractical travel mode choices. This impacts their ability to reach necessary goods and services like healthcare, food, education, and recreational activities. (New Jersey Travel Independence Program @ Rutgers)

In addition to PROWAG, planners and engineers rely on design guides like the Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD has been published by the Federal Highway Administration since 1971 and outlines national standards for all traffic control devices, including road markings, highway signs, and traffic signals.[7] The MUTCD was most recently updated in December 2023.

Throughout this primer, recommendations reference both PROWAG and the MUTCD for best practices for designing accessible pedestrian facilities.

Societal and Health Impacts

Although the main emphasis of this primer is an examination of transportation barriers encountered by the neurodivergent community, the research also aimed to comprehend the repercussions of these obstacles. **In essence, what are the outcomes when we fail to build a more equitable transportation network?**

First, an individual's access to high-quality transportation, characterized by safety, affordability, and reliability, significantly shapes their ability to reach necessary goods and services like healthcare, food, education, and recreational activities. As outlined in this primer, many members of the neurodivergent community cannot drive and/or reside in neighborhoods where walking and transit are impractical travel mode choices. Consequently, this demographic is often effectively segregated from accessing the basic necessities described above.

Secondly, neurodivergent individuals frequently encounter additional challenges in their daily lives compared to neurotypical persons, stemming from symptoms such as limited adaptive behaviors and sensory processing differences. These difficulties are distinct and go beyond what the general population typically experiences.

Employment

Notably, the research reveals alarmingly low rates of educational and employment attainment among adults with ASD, even in comparison to other marginalized demographics. Furthermore, when employed, adults with ASD often find themselves in part-time, low-skill positions with minimal compensation. These positions may also involve commuting during off-peak hours or during dark conditions. For those with ASD who do not drive a car, living in a community that is not walkable or transit-friendly can have a significant impact on access to employment. These elements converge to shape a reality wherein many neurodivergent adults encounter challenges in maintaining independent lifestyles and consequently force reliance on support from family, friends, and/or governmental assistance.

METHODOLOGY

Literature Review

Background information on autism spectrum disorder (ASD) and intellectual and developmental disabilities (IDDs) was synthesized from a review of literature from reputable institutional outlets, published books, and peer-reviewed scholarly articles. The literature review identified key symptoms and characteristics of those with ASD and IDDs, as well as the challenges these pose to safe walking, bicycling, and access to transit. . The review also focused on the 2015 *Detour to the Right Place* report to identify the transportation barriers experienced by New Jersey adults with autism. A full list of sources can be found in the Appendix.

Subject Matter Expert Interviews

The research team conducted subject matter expert interview sessions for this study focused on gathering information on two important topics: 1) the characteristics associated with neurodivergence that can make walking, bicycling, and accessing transit in one's community challenging; and 2) potential features and infrastructure improvements that could make walking, bicycling, and accessing transit in New Jersey safer and more inclusive for neurodivergent people. The research team asked specific questions about the following design features and how they could be improved: street crossings; traffic volume, noise, and speed; traffic signals; unsignalized intersections; crosswalks; sidewalks; pedestrian refuge islands; communication features; safety and comfort; and street lighting. The information provided through these subject matter expert interviews shaped the key takeaways and recommendations.

The research team identified 14 possible interview candidates based on the team's knowledge, experiences, and relationships with organizations supporting the neurodivergent community, as well as in consultation with Dr. Cecilia Feeley, based on her experiences in leading the New Jersey Task Force on Transportation, Mobility, and Support Service Needs of Adults with Autism.

The final list of selected interviewees is as follows:

- **The Arc of NJ** – The Arc of NJ is the state's largest organization advocating and serving neurodivergent children and adults and their families. The Arc is comprised of its central headquarters and 20 local county chapters. It should be noted that the Arc was involved with the passage of the inclusive Complete Streets legislation.
- **Community Living Education Project of New Jersey** – The Community Living Education Project of New Jersey initiative is part of Rutgers University. Their team provides information and education on community living resources for neurodivergent New Jersey residents and has extensive personal and professional experience supporting neurodivergent people.

Figure 4. Travel training for individuals with autism and intellectual and developmental disabilities. (New Jersey Travel Independence Program @ Rutgers)

- **Knowlton School at Ohio State University** – The research team interviewed Ohio State University based on their involvement in the 2018 development of a unique set of guidelines called Autism Planning and Design Guidelines 1.0 that offers community and design recommendations focused on promoting feelings of inclusion among persons with ASD.
- **NJ Travel Independence Program & RideWise TMA** – A joint interview was conducted with travel instructors from the Rutgers NJ Travel Independence Program (NJTIP) and the RideWise Transportation Management Association serving Somerset County. Instructors from both organizations often work with neurodivergent people to teach them how to safely and independently utilize public transportation in New Jersey.
- **NJ Council on Developmental Disabilities** – An interview was held with the NJ Council on Developmental Disabilities (NCDDD). NJCDD is one of 56 federally funded such councils, which focus on advancing policies and systems change to support neurodivergent people in areas including transportation.
- **Jespy House** - An interview was conducted with Jespy House, which is a non-profit that has been in operation in the South Orange area for over 45 years that supports neurodivergent adults with services including housing, transition, work readiness, and day habilitation program. Jespy focuses on promoting independent community living.
- **Self-Advocates** – An interview was conducted with two New Jersey-based self-advocates with intellectual and developmental disabilities. The self-advocates contributed information on their personal experiences regarding transportation challenges and needs as individuals with IDDs.
- **Planners with ASD** – Interviews were conducted with two professional urban planners with diagnoses of autism spectrum disorder. Both planners have conducted research on the topic of transportation challenges and needs for individuals with ASD and have previously presented on the topic together at a professional conference. Synthesizing the literature review and subject matter expert interviews, the research team identified key takeaways and developed a set of considerations related to expanding partnerships and conducting additional research (included below). Findings related to specific transportation barriers and possible improvements for neurodivergent individuals who walk, bike, and access transit are discussed in greater detail in subsequent sections.

KEY FINDINGS AND CONSIDERATIONS

Key Takeaways from Literature and Interviews

1. Neurodivergent individuals typically have severely limited transportation options and **most trips are completed as a passenger in a car**, which is an inconvenient arrangement that has negative consequences for both the neurodivergent individual and the person(s) providing transportation.
2. Combined rates of **ASD and IDD diagnoses are on the rise** and will continue to represent a growing demographic of the population and non-driving adults.
3. **High motor vehicle speeds are incompatible with pedestrian travel**, particularly for most people with ASD and IDDs. New Jersey state law sets a maximum speed limit of 25 mph in school zones, business, or residential districts and 35 mph in certain low-density business and residential districts [NJ Rev Stat § 39:4-98 (2024)]. In some cases, a Complete Streets approach that emphasizes traffic calming may be needed to ensure drivers follow posted speed limits.
4. Considerations for universal design should strive for **consistency among infrastructure treatments** while prioritizing safety for those with ASD/IDDs and acknowledging that some variations may be necessary depending on specific road contexts.
5. **Conflicting messages and movements should be reduced or eliminated, if possible**. For example, motor vehicle drivers should be discouraged from making left or right turns at the same time as people crossing the street.
6. **Layered approaches** that address multiple concerns simultaneously are preferred. For instance, offering both auditory and visual cues at crossings helps ensure that the different needs of different people are met.
7. Strategies that address pedestrian and bicycle **safety for young children** (under age 10) will also assist people with ASD/IDDs.

Figure 5. Travel training for individuals with autism and intellectual and developmental disabilities. (New Jersey Travel Independence Program @ Rutgers)

8. **Adoption of Complete and Green Streets policies** that comply with the new legislation (NJ Bill S-147 - Complete Streets for People with ASD and IDD) will raise awareness of the challenges the neurodivergent community faces and promote implementation of safe and accessible facilities for walking and bicycling.
9. The development of universal design considerations should be completed **in consultation with neurodivergent individuals, caregivers, and associated professionals.**
10. The ultimate realization of **a better pedestrian network will benefit everyone.** The design treatments discussed in this document and the barriers of challenging pedestrian environments are not unique to neurodivergence.

Considerations from Literature and Interviews

Ideas for Partnerships and Training

1. **Expand input and feedback to include neurodivergent representatives.** Passage of NJ Bill S-147 (Complete Streets for people with ASD and IDD) informed the creation of a working group that will ultimately make recommendations for universal design concepts to be adopted by the New Jersey Department of Transportation. While this group currently is composed of primarily NJDOT employees, membership could be expanded to include representatives of the neurodivergent population who are best positioned to advocate for the needs of other community members.

2. **Convene workshops and training on the topic of Complete Streets and neurodivergence.** As the resultant information from this research becomes available, current NJDOT Complete Streets training could be updated to include topics on addressing safety for neurodivergence populations. These educational sessions would increase public awareness of the universal design concepts developed to address a diverse range of pedestrian safety initiatives. Training and workshops provide an opportunity for NJDOT to encourage regional and local entities to adopt Complete Streets policies that comply with the provisions of NJ Bill S-147 and consider persons with ASD and/or IDDs.

3. **Participate in workshops, webinars, conferences, and committees that support persons with ASD and/or IDDs.** One of the best ways to implement best practices is to learn from experts and professional organizations that work with individuals with ASD and/or IDDs. As this topic evolves in research and implementation, efforts to expand knowledge through learning and participating in workshops, webinars, conferences, and committees hosted by national transportation forums like TRB and PROWAG and by leading organizations in ASD/IDD issues, should be encouraged.

4. **Partner with local police departments and advocates to explore expanding the blue envelope program to include neurodivergent people who walk, bike, and use transit.** Administered through county and municipal police departments, the blue envelope program currently issues envelopes to drivers with ASD that provide written information to ease interactions with law enforcement officers and could be expanded to neurodivergent individuals who walk, bike, and use transit. (This is described in more detail on page 24.)

5. **Pursue partnerships and explore new technologies.** Following S-146, which requires the Bureau of Research, Innovation & Information Transfer to consider the transportation and mobility needs of New Jersey residents with physical, sensory, intellectual, and developmental disabilities, NJDOT could pursue partnerships with organizations that represent the interests of the neurodivergent community to collaboratively explore innovative solutions to improve the comfort and safety of walking and bicycling for neurodivergent pedestrians. The Department could also seek partnerships in the science and technology sectors to develop safety applications. Multiple interviewees supported solutions such as phone applications that suggest multiple walking routes based on "level of stress," measured with factors like noise pollution and width of sidewalks, could help neurodivergent pedestrians plan trips. In addition, NJDOT could consider collecting and sharing data (such as sidewalk audits) so that Google and other technology developers can incorporate that information into their existing products.

Considerations from Literature and Interviews

Ideas for Future Investigation

1. **Consider the transportation and mobility needs of New Jersey residents with physical, sensory, intellectual, and developmental disabilities in future studies.** Following the provisions of S-146, studies conducted by NJDOT's Bureau of Research, Innovation & Information Transfer should include considerations for the transportation needs of neurodivergent persons where appropriate.

2. **Include partners from the neurodivergent community in real-world assessments such as walk audits, focus groups, and interviews.** To formalize and maintain ongoing input from the neurodivergent community, partnerships could be established with local organizations that support persons with IDDs or ASD, such as Jespy House in South Orange and the Arc of New Jersey. The neurodivergent members affiliated with these organizations could be participants in walk audits, focus groups, and interviews.

3. **Update walkability and bikeability assessments to address neurodivergence.** Walkability and bikeability assessments (sometimes called walk and bike audits) are a common public engagement tool, in which community members and decision-makers travel along a pre-determined route to observe and identify opportunities to improve the comfort and safety of the pedestrian and bicycling environment. The format of these activities and the categories of data collected are a well-established practice that already considers the mobility needs of a diverse range of road users. However, since the needs of neurodivergent pedestrians and bicyclists have, historically, been an under-observed area of study, tools could be updated to specifically direct participants of these assessments to consider the needs of neurodiverse populations.

Figure 6. Walk and bike audits could be updated to specifically consider the needs of neurodiverse populations. (NJDOT Safe Routes to School Resource Center)

4. **Develop evaluation methodology.** The Department could develop an assessment process or tool to evaluate future projects that address Complete Streets for neurodivergence. Updating NJDOT's Complete Streets checklists and the checklists and benchmarking included in the Complete and Green Streets Model Policy and Guide could be explored. This would help measure progress as design treatments are implemented.

Figure 7. Since neurodivergent people often process sensory information differently than the general population, intervention testing should specifically attempt to address this issue. (NJDOT Safe Routes to School Resource Center)

5. **Create model language for plans related to individuals with ASD and IDDs.** Consider developing model language for plans that affect neurodivergent individuals, including but not limited to:

   a. **ADA Transition Plans** for government entities which outline a process for eliminating transportation barriers over time. These plans, including NJDOT's ADA Transition Plan which was recently updated in 2023, can be expanded to proactively address accessibility issues and ensure that individuals with ASD and IDDs have equal access to programs, services, and facilities as required by the ADA.

   b. **Individualized Education Plans (IEPs)** for schools and school districts which address youth with ASD and IDDs. IEPs can be designed to incorporate walking, bicycling, and travel training/instruction, providing neurodivergent individuals with active transportation skills from a young age. Model language for IEPs regarding walking, bicycling, and transit education could be developed in partnership with school special education experts.

6. **Update existing websites, guides, and plans to address neurodivergence.** NJDOT provides many websites, guidance documents, and plans that are used both inside the Department and by practitioners at the regional and local levels. Documents including NJDOT's ADA Transition Plan, Roadway Design Manual, Complete Streets Design Guide, School Zone Design Guide, and others can be evaluated for inclusion of guidelines and recommendations to address access and safety of the neurodivergent community.

7. **Test interventions that address visual, auditory, and tactile input.** Since neurodivergent people often process sensory information differently than the general population, intervention testing should specifically attempt to address this issue. For instance, treatments that reduce the impact of noise pollution from vehicles and/or offer pedestrians shelter from inclement weather benefit neurodivergent individuals but may also create a more comfortable environment for all road users. Intervention testing can be conducted in a controlled

environment prior to the implementation of a pilot program (see folllowing consideration). Further testing of wayfinding elements would help to identify best practices for use of words, graphics, and color.

8. **Conduct pilot programs and testing of interventions.** "Quick build" or pilot programs can be implemented to test some of the preliminary design treatments. These low-cost programs can be used to collect important qualitative and quantitative data that may support the efficacy and replication of such treatments across a wide range of settings.

9. **Test emerging technology including biometric sensors, eye tracking feedback, and virtual reality.** Biometric and eye-tracking feedback technologies are emerging tools in the field of transportation planning that have been used to quantify formerly qualitative experiences. For example, some studies have used wearable technology to track eye movements, record heartbeats, and measure perspiration on pedestrians while they travel. The results of such data can quantitatively support the level of stress experienced by a pedestrian or bicyclist who travels along a particular roadway segment. In addition, simulated real-world trips through virtual reality environments could document barriers and aid in determining support needed. Further deployment of such technologies could be used with neurodivergent pedestrians across New Jersey, which can be aggregated to create a "level of stress" map for neurodivergent pedestrians in a similar way to high injury network.

10. **Leverage federal funding opportunities to further study transportation for neurodivergent individuals.** NJDOT could take advantage of federal funding through programs, such as the National Cooperative Highway Research Program (NCHRP), the Transit Cooperative Research Program (TCRP), and the American Association of State and Highway Transportation Officials (AASHTO), to advance studies on travel for those with ASD and IDDs and build on the foundational knowledge gained through this project.

Figure 8. Simulated real-world trips through virtual reality environments could document transportation barriers for neurodiverse people. (NJDOT Bicycle and Pedestrian Resource Center)

RESEARCH AND CONSIDERATIONS

ASD, IDDs, and Invisible Disabilities

Autism Spectrum Disorder (ASD) is a condition that primarily affects how people learn, communicate, and process sensory information.[8] ASD is known as a spectrum disorder because there is wide variation in the type and severity of symptoms people experience. Historically, the terms "low functioning" and "high functioning" were used to describe the level of independence a person with ASD has in relation to their symptoms. However, at the time of writing, these terms have been replaced with "levels" of ASD that describe this concept.[9]

In the state of New Jersey, approximately one in 35 8-year-old children, or 2.9%, have received a diagnosis of ASD.[10] Given the difficulty of assessing those who are no longer in school, there is a lack of data on rates of autism among adults. However, the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) notes that prevalence rates for adults and children were found to be similar in samples drawn in several countries.[11] Autism diagnoses among children have risen in recent decades which may be attributed, in part, to advancements in the medical community's comprehension of the disorder and more sophisticated diagnostic procedures that allow for earlier and more precise detection. For example, Aspergers Syndrome, once considered a unique disability, is now encompassed within the broader framework of ASD diagnoses.[12]

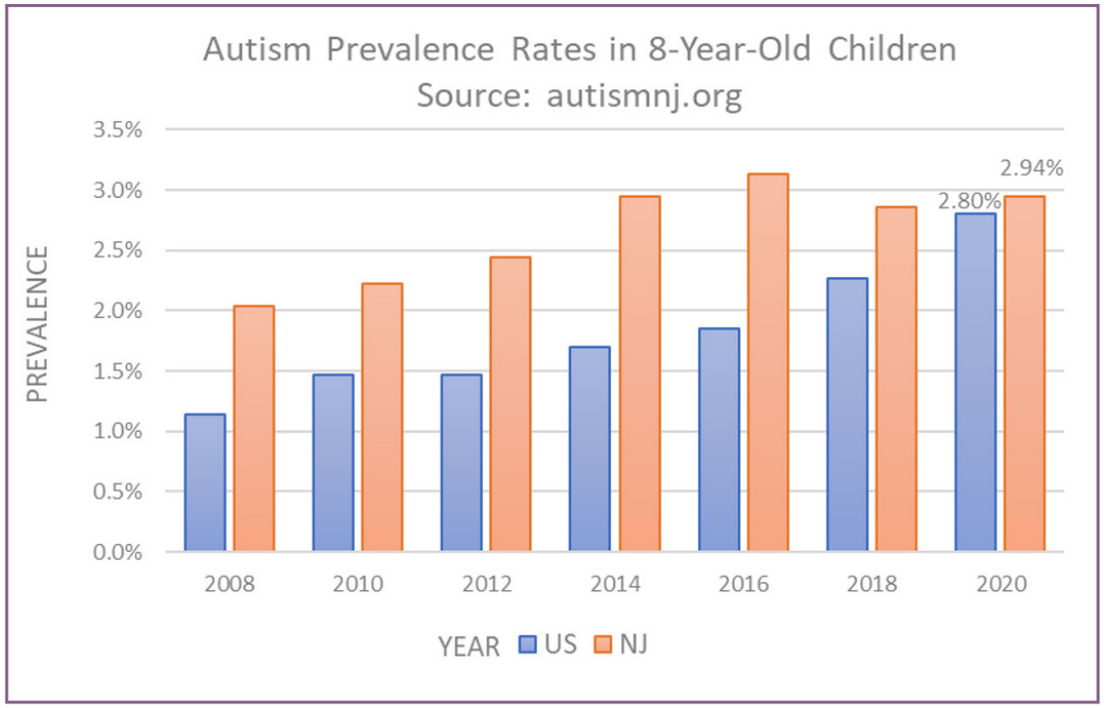

Figure 9. Prevalence rates of ASD in 8-year-old children in NJ and the US. (autismnj.org)

Intellectual and/or Developmental Disabilities (IDDs) represent an umbrella classification encompassing a diverse array of diagnoses that are usually present at birth and uniquely affect the trajectory of an individual's physical and/or intellectual and emotional development. Many of these conditions affect multiple body parts or systems.[13] Examples of IDDs include Attention Deficit Hyperactivity Disorder (ADHD), Cerebral Palsy, and Down Syndrome.

Unlike ASD, which is a singular diagnosis, IDDs encompass a wide variety of diagnoses, thereby leading to a variety in prevalence data. For example, in 2016, about 8.4% of children aged 2-17 in the United States, received an ADHD diagnosis.[14] By comparison, Cerebral Palsy affects about 0.3% of children in the United States.[15] Excluding ASD, CDC data indicates the overall prevalence of IDDs impacting cognitive development ranges between 2% and 6% among children.[16]

Invisible Disabilities are mental health diagnoses, exemplified by conditions such as Post Traumatic Stress Disorder (PTSD) and Obsessive Compulsive Disorder (OCD), which do not traditionally fall within the purview of the "neurodiversity" definition. Nonetheless, people with these diagnoses may – on occasion – exhibit similar symptoms to the neurodiverse population, including temporary disruptions in adaptive behaviors. From several sources in the research, the term "Invisible Disabilities" emerged as an encompassing classification for any disorder that is not immediately visible when observing someone.[17] While the focus of this primer, and of NJ Bill S-147, lies primarily with ASD and IDDs, it is important to note invisible disabilities represent a protected class under ADA law and persons living with these disabilities can similarly benefit from enhancements to the built environment.

Findings

Symptoms and Barriers to Transportation

Given the broad spectrum of symptoms experienced by people with ASD and IDDs, it might seem challenging to develop universal design concepts that address the needs of all neurodivergent individuals. However, there are symptoms which are common across a range of conditions. For instance, speech and language delays are prevalent among people with ASD and various IDDs including Fragile X Syndrome and Cerebral Palsy.[18] While every individual is unique and not every person diagnosed with ASD or an IDD will experience every symptom, these symptoms pose a set of common transportation barriers for neurodivergent individuals which can guide the development of universal design concepts. The most common symptoms identified in the research are:

1. Cognitive impairment
2. Attention disorders and fixation tendencies
3. Speech and language delays
4. Learning disorders
5. Difficulties navigating social situations
6. Difficulties tolerating sensory input[19]

Many of these symptoms affect a broader set of skills known as **adaptive behaviors**, which are the collection of conceptual, social, and practical skills all people learn to function in their daily lives.[20] Examples of adaptive behaviors include language and literacy, personal hygiene, interpersonal skills, and the ability to avoid being victimized.

The following visuals illustrate how these common symptoms and their resultant barriers may impact independent travel for neurodivergent people. It is important to note that many of the transportation challenges faced by neurodivergent individuals affect neurotypical people as well.

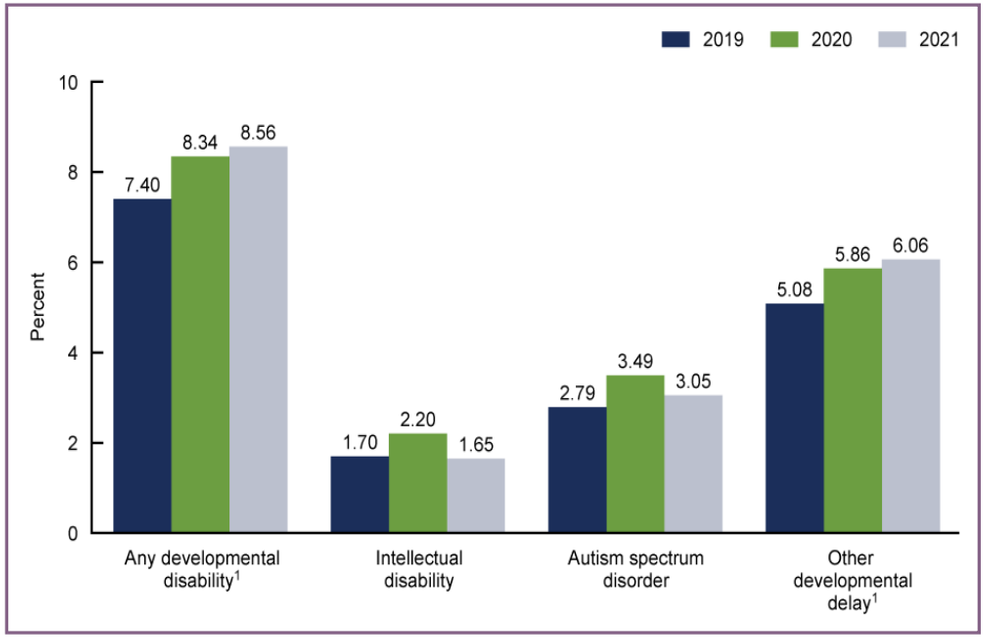

Figure 10. Prevalence of children aged 3-17 years ever diagnosed with selected developmental disabilities, by year: United States, 2019 - 2021. (cdc.gov)

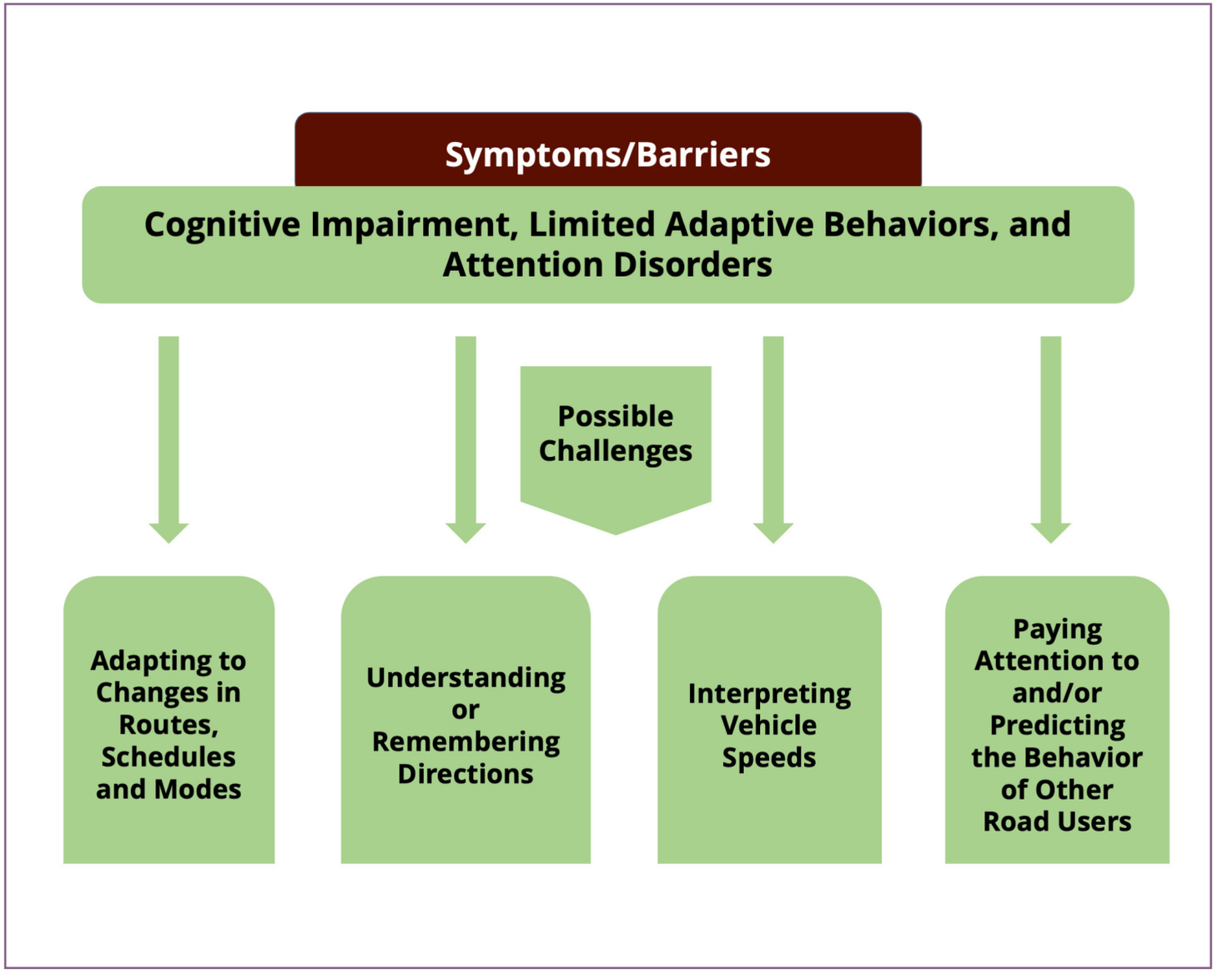

Figure 11. Poor adaptive behaviors may inhibit a person's ability to quickly adjust their travel route when experiencing a road closure or transit delay.

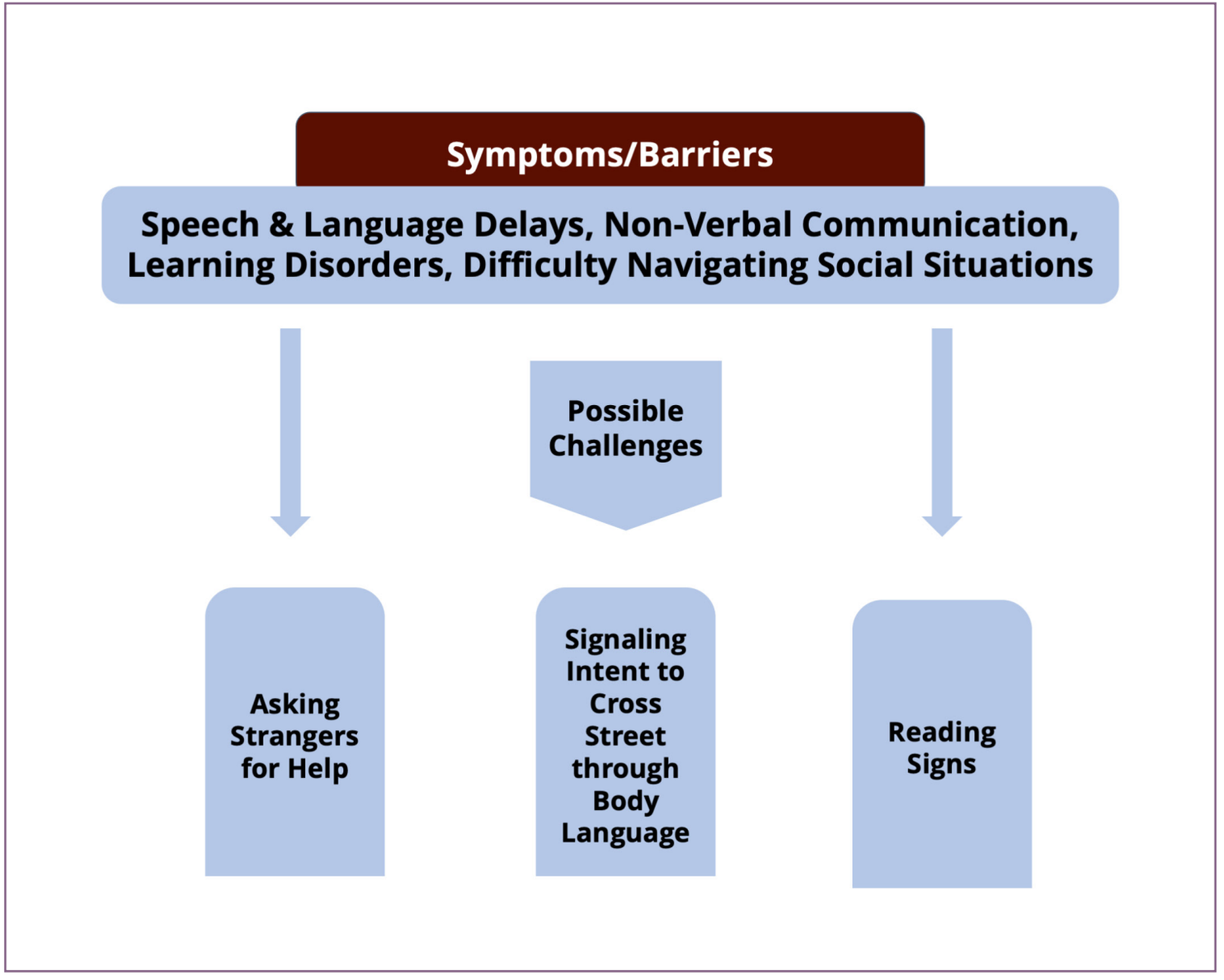

Figure 12. Difficulty navigating social situations may deter a neurodivergent person from requesting directions from a stranger.

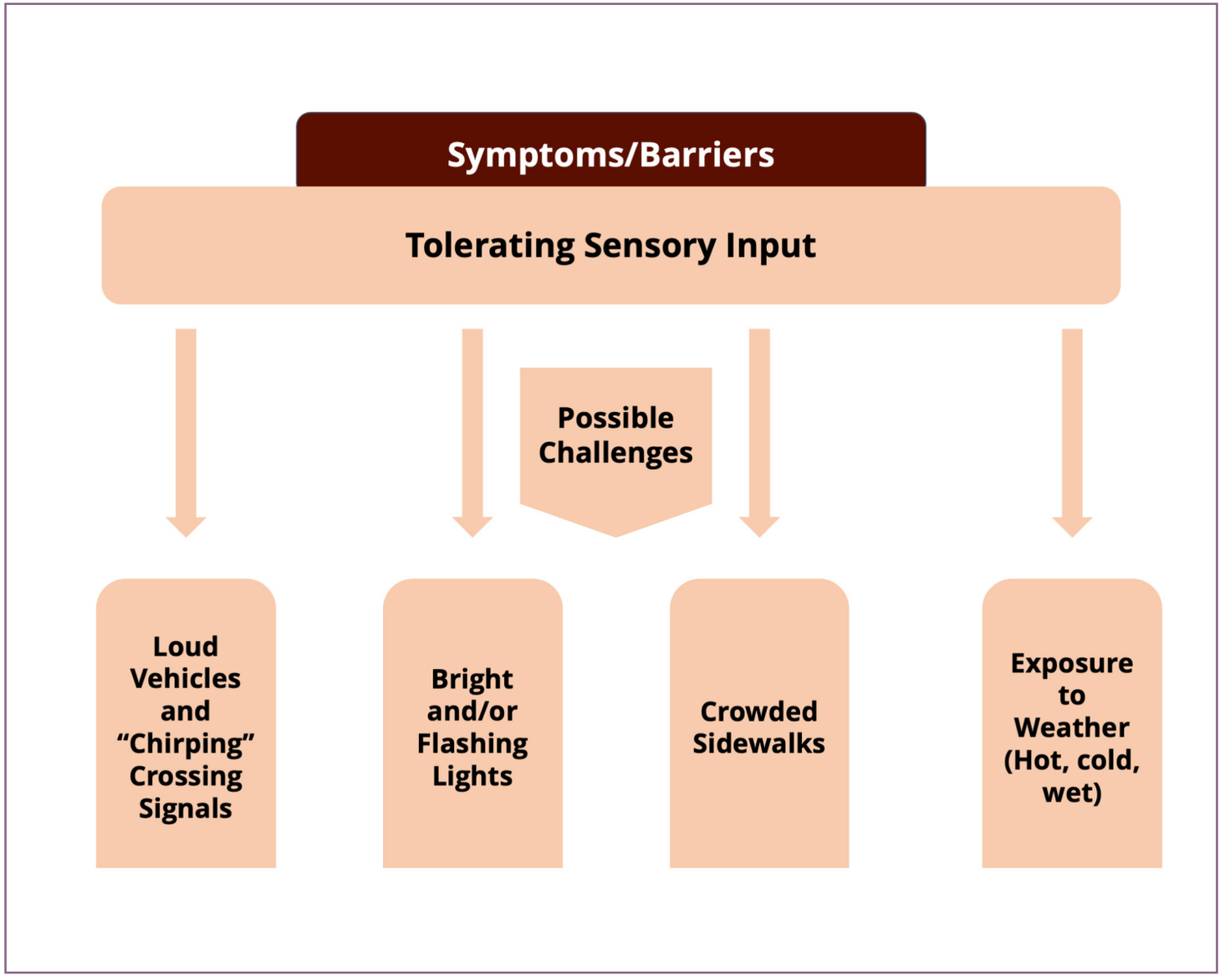

Figure 13. Noise pollution from fast-moving, large vehicles may overwhelm a neurodivergent person walking near traffic.

Transportation Challenges and Potential Improvements for Neurodivergent Individuals

Driving

A New Jersey survey with responses from 703 adults with ASD and caregivers conducted as part of the *Detour to the Right Place* study revealed that only 3.1% of the adults with ASD surveyed drove themselves in the previous three months.[21] In contrast, the National Household Travel Survey noted that 87.4% of all trips in the United States in 2020 were completed by car.[22] These statistics highlight a significant disparity between the transportation needs of a non-driving demographic and the prevailing reliance on automobiles nationwide. As a result, neurodivergent individuals often heavily depend on rides from caregivers, family, and friends as their primary mode of transportation.

This inconvenient transportation arrangement often leads to missed appointments for both people with ASD and/or IDDs as they struggle to secure rides when needed, as well as the caregivers, family members, and friends providing the transportation.[23] In cases where a ride from a caregiver or friend is unavailable, individuals with ASD may have no other option but to walk to their destination.

Most people with ASD do not drive, but some may feel pressured into purchasing a car when there are few other options. This may be the case with neurodivergent individuals who experience physical symptoms that make walking or transit use difficult. In the interviews conducted by the research team, those with ASD who do drive described feeling constantly worried about making a mistake while operating a motor vehicle. With so much data to process, the experience of driving can be overwhelming for neurodivergent individuals and can cause some with ASD to have trouble recalling information such as left and right directions. In addition, sensitivity to sensory stimuli, including sudden, loud noises or bright lights (such as light from the sun or headlights), can make driving difficult. Research comparing crashes involving autistic drivers versus non-autistic drivers found that those with ASD were less likely to crash due to unsafe speed, but substantially more likely to crash due to their failure to yield to a vehicle/pedestrian and while making left- or U-turns.[24] While concerns related to driving fell outside the scope of this study, additional research on this topic is needed to improve safety and mobility for neurodivergent drivers.

New Jersey's Blue Envelope Programs

Many county and municipal police departments throughout New Jersey have developed programs that issue "blue envelopes" to persons diagnosed with autism.[25] In addition to holding driver's license, motor vehicle registration, and insurance identification card,

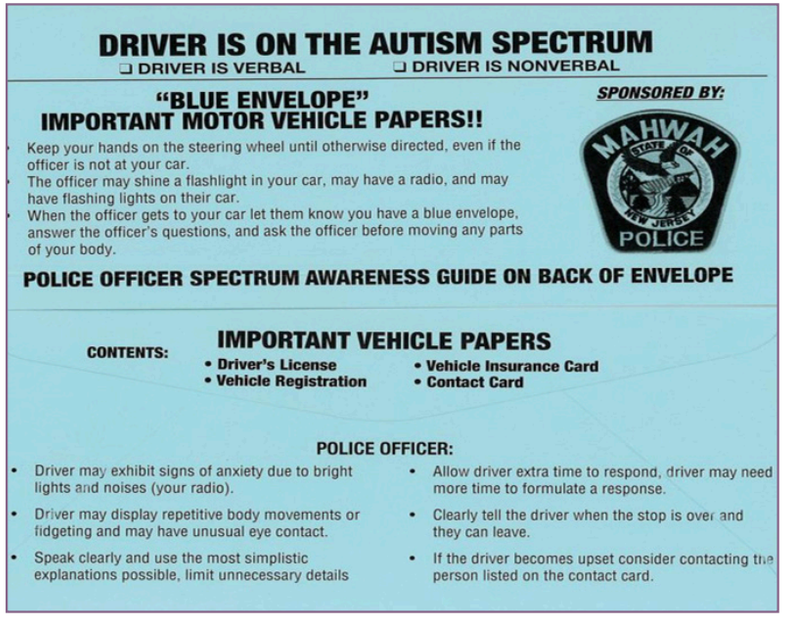

Figure 14. Example of a blue envelope provided by local police to drivers with autism. (Mahwah Police Department)

these clearly-marked envelopes notify law enforcement officers that a driver has been diagnosed with autism spectrum disorder and provide written information for officers on effectively communicating with a person with autism. The envelopes also contain written information for drivers with autism outlining what may happen during a traffic stop so they can be prepared to interact with an officer.

Like drivers with ASD and IDDs, neurodivergent individuals who walk, bike, and use transit may be approached by law enforcement and may not be able to respond in a way that is understood by the officer. To ease interactions with officers, the blue envelope program could be expanded to include neurodivergent people using non-motorized transportation.

The Connection Between Speed and Safety

Vehicles traveling at high speeds pose a significant safety risk to pedestrians and other travelers. This concern is heightened for neurodivergent individuals who are walking or using low-speed wheeled vehicles like bicycles since the symptoms of some neurodivergent conditions may inhibit a person's ability to **accurately judge the speed of oncoming vehicles** when crossing the road. Furthermore, neurodivergent people who also have **physical impairments may be at further exposure to speeding vehicles** as they may spend more time in the crosswalk as they cross the road. The survey conducted for the *Detour to the Right Place* study found that 45.2% of respondents had difficulty judging the distance and/or speed of cars and that 41.3% experienced challenges when crossing a street.[26]

Slower speeds (under 25 mph) improve safety for all road users, but have a particular benefit for people with ASD and IDDs. Evidence shows that **traffic calming** measures can be an effective tool to reduce traffic speeds and both the frequency and severity of crashes.[27] Traffic calming is a purposeful tactic employed by planners and engineers, involving the strategic use of design elements to curtail speed. For instance, the incorporation of **narrow travel lanes prompts drivers to naturally reduce their speed** due to a perception of limited space, contributing to a safer environment for all road users. Likewise, the design of **intersections with tighter curb radii requires drivers to navigate more slowly** and be more attentive to their surroundings. **Raised crosswalks simultaneously force drivers to slow down and increase pedestrian visibility** by physically elevating those crossing the road. Other interventions such as **street trees on lower-speed roadways can reduce speeds by narrowing drivers' field of vision**. New streets can be built to reinforce slower speeds and existing streets can be modified through traffic calming to achieve slower speeds. In addition, speed limits can reinforce slower speeds.

Figure 15. Walking is a top mode of transportation for New Jersey adults with ASD, with one survey finding nearly a third of respondents having walked in the previous three months. (NJDOT Bicycle and Pedestrian Resource Center)

Walking and Active Transportation

The survey conducted for *Detour to the Right Place* found that walking was the second most common transportation mode among New Jersey respondents living with ASD, with 28.6% of them indicating they had walked during the previous three months.[28] This finding further supports the importance of exploring and prioritizing the implementation of strategies to improve the built environment to promote safe walking and active transportation among neurodivergent persons. Top physical barriers to walking in their respective neighborhoods as indicated by survey respondents focused on the absence or poor quality of sidewalks and pathways and poor quality of street crossings and intersections. This corresponds with research on children and traffic safety. Young children are more vulnerable to crashes when crossing the street because, until the age of 9 or 10, they lack the motor and cognitive skills required to safely navigate many traffic situations.[29] Thus, strategies that improve conditions for walking and bicycling for people with ASD and IDDs also increase safety for young children and vice versa.

Sidewalks

In interviews, participants discussed that **insufficient, or the outright absence of, pedestrian infrastructure like sidewalks** makes walking more challenging or discourages walking altogether. For those who choose to walk in such conditions, or have no other choice, the dilemma arises of opting to either walk in the road, risking exposure to cars, or traversing private property, which many with ASD and IDDs are reluctant to do out of fear of causing conflict with landowners. When they are provided, sidewalks often have design and maintenance shortcomings including, being too **narrow**, lacking ADA-compliant features like curb cuts, being in poor condition, and **abruptly ending** without connecting to the broader regional network. In addition, many individuals with ASD experience sensory sensitivity, and bright light from the sun can pose a challenge when walking.

Figure 16. Wide sidewalks with a buffer between the sidewalk and adjacent traffic helps to reduce sensory issues. (NJDOT Bicycle and Pedestrian Resource Center)

Symptoms: Cognitive Impairment, Limited Adaptive Behaviors, and Attention Disorders	
Challenges for those with ASD/IDDs	**Improvements Suggested in Interviews**
• Lack of sidewalk network connectivity that forces those with ASD/IDDs to alter routes or remember complex directions.	• Prioritizing sidewalk connections to broader regional networks.

Symptoms: Tolerating Sensory Input	
Challenges for those with ASD/IDDs	**Improvements Suggested in Interviews**
• Lack of sidewalk infrastructure and network connectivity that forces those with ASD/IDDs to walk in high-stress environments, such as on private property or in the roadway	• Sidewalks on both sides of all streets • Prioritizing sidewalk connections to broader regional networks
• Sidewalk design that compels those with ASD/IDDs to walk close to sensory stressors, such as near motor vehicle traffic or other people	• Minimum width of 5 feet for sidewalks with a buffer between the sidewalk and adjacent traffic to reduce sensory issues (PROWAG requires a minimum of 4 feet of continuous clear width for unobstructed pedestrian access routes) • Planting strips between the curb and walking path. • Trees that provide both shade from the sun and a natural buffer between the sidewalk and the street
• Sidewalk design that lacks accessibility features, making walking especially difficult for those with ASD/IDDs	• ADA-compliant design features, such as curb cuts and level pavement

Figure 17. Trees can provide both shade from the sun and a natural buffer between the sidewalk and the street. (NJDOT Bicycle and Pedestrian Resource Center)

Crosswalks

Crosswalks serve as designated paths for pedestrians to cross the road safely. In New Jersey, drivers are mandated to stop and stay stopped for pedestrians in crosswalk[30] ; however, there is inconsistent adherence to and enforcement of this law. Moreover, **many crosswalks are not well marked or marked at all**. Unmarked crosswalks can create confusion for all people but are a significant challenge for people with ASD and IDDs because they are often cognitively unable to determine where to cross the street without the guidance of a marked crosswalk. To address these concerns, crosswalks should be well-lit and clearly marked, preferably using **high-visibility designs that provide clear guidance to both motorists and pedestrians.**

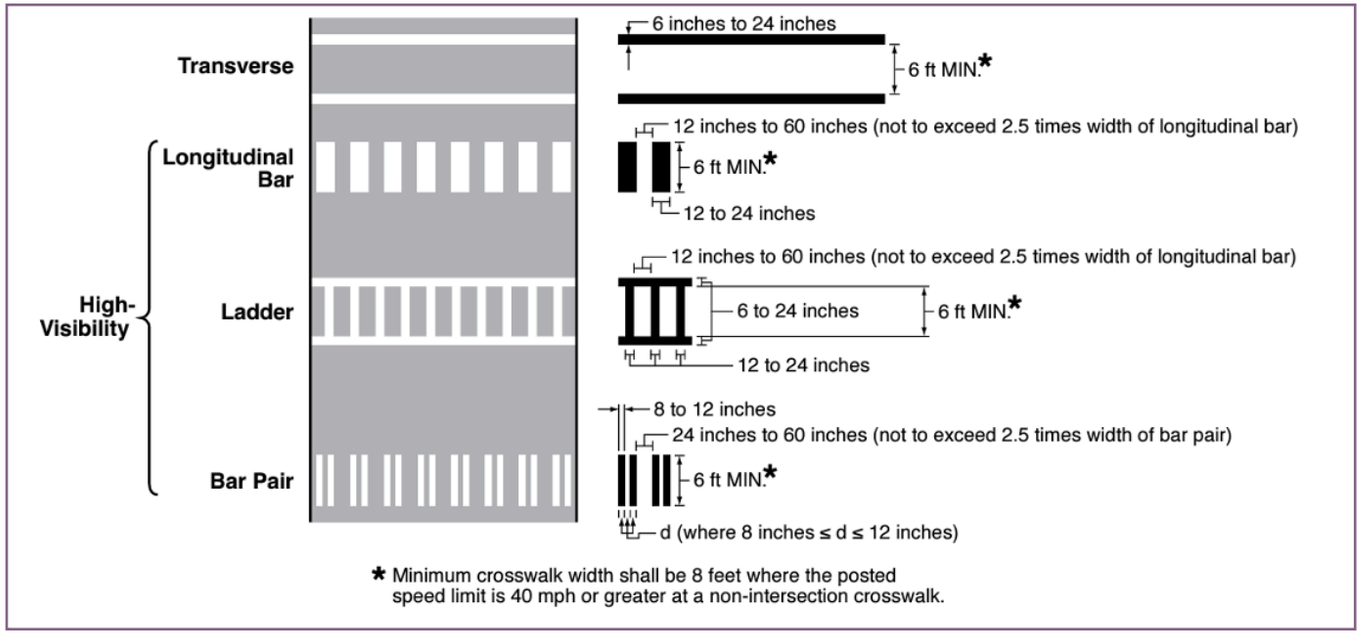

Figure 18 (above). MUTCD-approved crosswalk marking types. (11th Edition of the Manual on Uniform Traffic Control Devices)

Figure 19 (left). Crosswalk marking types from low to high visibility. (NJDOT Safe Routes to School Resource Center)

Figure 20. Parking restrictions on crosswalk approaches can improve sightlines for motorists and pedestrians. New Jersey law prohibits parking within 25 feet of a crosswalk and 50 feet of a "stop" sign. (NJDOT Bicycle and Pedestrian Resource Center)

Symptoms: Cognitive Impairment, Limited Adaptive Behaviors, and Attention Disorders	
Challenges for those with ASD/ IDDs	**Improvements Suggested in Interviews**
• Unmarked crosswalks which cause confusion for those with ASD/IDDs who may be cognitively unable to determine where to cross the street	• Clearly marked crosswalks that are well-lit and use high-visibility designs (such as MUTCD-approved longitudinal, ladder, or bar pair style markings) that incorporate reflectors or fluorescent paint (see Figures 18 and 19)
• Lack of high-visibility markings and signage that indicates the presence of crosswalks to drivers	• "STOP" markings and in-street pedestrian crossing markings in advance of crosswalks
• Lack of features that slow vehicle speeds, improve pedestrian visibility, and increase feelings of safety for pedestrians with ASD/ IDDs who may have difficulty interpreting vehicle speeds and predicting the behavior of other road users	• Parking restrictions on crosswalk approaches to improve sightlines for motorists and pedestrians, including New Jersey's law prohibiting parking within 25 feet of a crosswalk and 50 feet of a "stop" sign [N.J.S.A 39:4-138] • Installation of raised crosswalks to slow vehicle traffic and improve pedestrian visibility

Signalized Intersections

Signalized intersections control traffic flow using lights that indicate when road users can enter the intersection, eliminating the need for drivers and pedestrians to assess safe gaps in traffic.[31] Judging adequate gaps in traffic can be especially challenging for individuals with ASD and IDDs, as well as children, who will wait until an intersection is completely clear of vehicular traffic before crossing the street. In some cases, this can result in long wait times to cross. Consequently, many members of the neurodivergent community prefer the clear guidelines inherent in signalized intersections. However, these signals often lack pedestrian signal heads and adequate pedestrian clearance intervals, leading to **confusion about when to cross and conflict points between people crossing the street and cars.**

For example, an instance of concern noted in interviews is when motor vehicles are granted permissive left-turns, which means a green signal for motorists turning left at the same time that pedestrians have the "walk" signal. This results in confusing and conflicting messages to the person waiting on the sidewalk. Another example is allowing right turns on red. Where right turns on red are permitted, drivers often focus on oncoming traffic on their left, and pay little attention to people attempting to cross. **A clear no-right-turn-on-red** policy reduces conflict between pedestrians and drivers and benefits individuals with ASD and IDDs, children, and those with mobility issues. To avoid these types of conflicts, **dedicated pedestrian crossing phases should be considered**.

Figure 21. Accessible pedestrian signals can better communicate pedestrians' right of way by combining visual, aduitory, and vibrotactile cues that work in concert to convey information about how and when to cross the street. (NJDOT Bicycle and Pedestrian Resource Center)

Other proposed enhancements to these crossings might include **extending signal durations**, and installing **leading pedestrian intervals (LPI)**, which give people the opportunity to enter the crosswalk at an intersection 3-7 seconds before vehicles are shown a green light. PROWAG notes that the crossing times should be sufficient to allow pedestrians with disabilities sufficient time to cross.

Additionally, the use of **accessible pedestrian signals** can better communicate pedestrians' right of way by combining visual countdowns, bright "walk" signals, auditory numeric countdowns, and vibrotactile arrow buttons that work in concert to convey information about how and when to cross the street. PROWAG requires all new and altered pedestrian signal heads installed at crosswalks to include accessible pedestrian signals (APS) that are accessible to those in wheelchairs and provide audible and vibrotactile indicators to ensure pedestrians with blindness or low vision can safely cross the street.[32] PROWAG section R308 also sets guidance for speech information messages that indicate the direction of travel across a particular intersection as well as when it is safe to cross.[33] The redundancy provided by multi-layered signals is beneficial to neurodivergent individuals who may be able to better comprehend some forms of communication over others. In one interview, it was noted that some with ASD may experience sensory sensitivity and would benefit from signals with buttons that allow auditory announcements to be temporarily silenced.

Symptoms: Cognitive Impairment, Limited Adaptive Behaviors, and Attention Disorders

Challenges for those with ASD/IDDs	Improvements Suggested in Interviews
• Difficulty judging vehicle speeds and assessing safe gaps in traffic, leading to confusion about how and when to cross the street	• Signalized intersections that include pedestrian signal heads, adequate pedestrian clearance intervals, and leading pedestrian intervals • Inclusion of FHWA well-designed right-turn slip lanes
• Difficulty interpreting who has the right of way in situations where there are confusing or conflicting signals, such as instances when vehicles have permissive left turns on green or right turns on red	• Dedicated pedestrian crossing phases that prohibit simultaneous left turns for motor vehicles • Prohibition of right turns on red
• Differences among those with ASD and IDDs in how information is most easily interpreted, including forms of visual, audible, and tactile communication	• Accessible pedestrian signals (APS) that combine visual countdowns, bright "walk" signals, auditory numeric countdowns, and vibrotactile arrow buttons • APS that include an option that allows auditory announcements to be temporarily silenced

Other Concerns

Challenges for those with ASD/IDDs	Improvements Suggested in Interviews
• Inadequate time allotted to cross the street, due to cognitive or physical disabilities associated with ASD and IDDs	• Extending the default duration of pedestrian signal phases to meet current MUTCD and PROWAG guidelines • Providing optional extended pedestrian phases with signage indicating how to activate extended phases

Unsignalized Intersections and Mid-Block Crossings

Unsignalized intersections and many mid-block crossings lack traffic control devices such as signals that indicate to road users when they have the right of way, instead requiring users to assess when a safe gap in traffic allows them to cross. The informal nature of crossing etiquette at these intersections can pose challenges for members of the neurodivergent community, as well as children, who may feel unsafe or uncomfortable navigating such crossings. Neurodivergent individuals may also have difficulty gauging the speed of oncoming vehicles and judging adequate gaps in traffic. As a result, some neurodivergent pedestrians may wait at unsignalized crossings until there are no vehicles present at all, while others may opt to avoid these crossings altogether, even if it means taking a longer route. Such scenarios may warrant the **installation of lighted beacons at uncontrolled crossings**, such as Rectangular Rapid-Flashing Beacons (RRFBs), or measures like **high-visibility crosswalks, in-street pedestrian crossing signs (MUTCD R1-6 or R1-6a), curb extensions, parking restrictions, pedestrian scale lighting, and warning signs** to increase pedestrian visibility at crossing locations and make it clearer to those with ASD and IDDs when and where to cross.[34]

Figure 22. Rectangular Rapid-Flashing Beacons (RRFBs) and high-visibility crosswalks can increase pedestrian visibility at mid-block crossings. (NJDOT Bicycle and Pedestrian Resource Center)

Symptoms: Cognitive Impairment, Limited Adaptive Behaviors, and Attention Disorders

Challenges for those with ASD/IDDs	Improvements Suggested in Interviews
• Difficulty judging vehicle speeds and assessing safe gaps in traffic, leading to confusion about how and when to cross the street • Difficulty interpreting who has the right of way in situations where traffic signals and pedestrian beacons are absent	• Installation of lighted pedestrian traffic beacons • Installation of crosswalk enhancements that increase pedestrian visibility and indicate to those with ASD and IDDs where and when to cross, including high-visibility crosswalks, in-street pedestrian crossing signs, curb extensions, parking restrictions, pedestrian scale lighting, and warning signs

Pedestrian Refuge Islands

A pedestrian refuge island is a median strip on a roadway designed to offer a standing area for people crossing multiple lanes of traffic, allowing pedestrians to concentrate on one direction of traffic at a time and improving safety. This design treatment may relieve the cognitive load for pedestrians who struggle to simultaneously process multiple stimuli. However, some neurodivergent individuals may also feel overwhelmed if they perceive themselves as "trapped" by heavy, loud traffic on both sides of the island. Thus, refuge islands should be designed to **provide ample waiting space for multiple people** (PROWAG requires a minimum width of 5 feet). Additionally, **islands should include pedestrian scale lighting and push buttons for signalized crossings**.[35] In interviews, participants identified the desire for more space in medians for pedestrians with ASD and IDDs to rest and avoid sensory stressors while awaiting awaiting their turn to cross the remainder of the intersection. Benches or bars that pedestrians can lean against may be added to medians where space allows. Figure 23 shows how medians can be expanded to accommodate infrastructure that improves safety for pedestrians and bicyclists, such as widened sidewalks, seating, pedestrian-scale lighting, bicycle lanes, and street trees. In some cases, travel lanes for motor vehicles may be narrowed to allocate more space for wider medians.

Figure 23. Medians can be widened to accommodate pedestrian- and bicyclist-oriented infrastructure like wider sidewalks, seating, pedestrian-scale lighting, bicycle lanes, and street trees. (National Association of City Transportation Officials [NACTO] and the New York City Department of Transportation [NYCDOT])

Figure 24. Refuge islands can include features such as pedestrian push buttons, MUTCD-approved signage, and beacons. (NJDOT Bicycle and Pedestrian Resource Center)

Symptoms: Cognitive Impairment, Limited Adaptive Behaviors, and Attention Disorders	
Challenges for those with ASD/IDDs	**Improvements Suggested in Interviews**
• Difficulty judging vehicle speeds and assessing safe gaps in traffic	• Pedestrian refuge islands that break up long crossings into shorter segments
• Difficulty interpreting who has the right of way in situations where traffic signals and pedestrian beacons are absent	• Refuge islands with features such as pedestrian push buttons, MUTCD-approved signage, and beacons

Symptoms: Tolerating Sensory Input	
Challenges for those with ASD/IDDs	**Improvements Suggested in Interviews**
• Lack of space in refuge island waiting areas that can lead to those with ASD/IDDs feeling "trapped" or overwhelmed by motor vehicle traffic or other pedestrians	• Larger waiting areas for multiple pedestrians at refuge islands • Where space allows, benches or lean bars that allow pedestrians to rest before completing a crossing • Pedestrian scale lighting to increase comfort in dark conditions

Roundabouts

Roundabouts are intersections designed with a circular configuration that uses channelized, curved approaches to safely move traffic around a center island.[36] As Federal Highway Administration Proven Safety Countermeasures, roundabouts increase safety for both drivers and pedestrians by reducing vehicle speeds and minimizing conflict points, resulting in far fewer high-speed crashes and decreasing the chances of injury. For neurodivergent individuals, roundabouts can be a benefit because they read logically for both drivers and pedestrians. As a pedestrian, it is easy to determine how the driver of a vehicle intends proceed through the intersection well in advance. This reduces the amount of sensory information a neurodivergent pedestrian needs to process and therefore improves the walking experience for those with ASD and IDDs.

At the same time, education for neurodivergent individuals on how to safely use a roundabout is crucial. Many people, including those in the neurodivergent community, are not familiar with roundabouts and how they work. Roundabouts may be especially confusing for neurodivergent individuals who are encountering one for the first time. With the increasing implementation of roundabouts throughout New Jersey and beyond, educational efforts are needed to ensure those with ASD and IDDs understand how to safely navigate a roundabout.

Figure 25. For neurodivergent individuals, roundabouts are a benefit because they read logically for both drivers and pedestrians. (NJDOT Bicycle and Pedestrian Resource Center)

Symptoms: Cognitive Impairment, Limited Adaptive Behaviors, and Attention Disorders	
Challenges for those with ASD/IDDs	**Improvements Suggested in Interviews**
• Difficulty interpreting who has the right of way in situations where there are confusing, conflicting, or absent signals	• Expanded use of roundabouts to improve intersection "legibility" for those with ASD and IDDs • Education for those with ASD and IDDs on how to safely navigate roundabouts
• Difficulty judging vehicle speeds and assessing safe gaps in traffic	• Expanded use of roundabouts to clearly delineate how and when to cross the street

Symptoms: Tolerating Sensory Input	
Challenges for those with ASD/IDDs	**Improvements Suggested in Interviews**
• Intersections where high vehicle speeds and loud noises make it difficult to process sensory stimuli	• Expanded use of roundabouts to slow vehicle speeds, reduce conflict points, and lighten the cognitive load for neurodivergent individuals at intersections

Figure 26. Roundabouts can slow vehicle speeds, reduce conflict points, and lighten the cognitive load for neurodivergent individuals at intersections. (Google Maps)

Wayfinding

Neurodivergent individuals can benefit from enhanced wayfinding tools that communicate important information about the locations of important destinations and how to safely navigate there. Wayfinding works best when signage is **highly visual, using universal icons that are widely understood**. Colors used for wayfinding purposes should be limited to avoid creating visual clutter or confusion. Ohio State University's Autism Planning and Design Guidelines propose a specific magenta color to be used on wayfinding signage and elements as a universal symbol that individuals with ASD can recognize. Digital wayfinding signage which **communicates information visually, auditorily, and tactilely** was suggested in interviews. Currently, research in this area is limited and further studies are needed to determine how best to incorporate words, graphics, colors, and other communication features in wayfinding signage aimed at neurodivergent individuals.

Symptoms: Cognitive Impairment, Limited Adaptive Behaviors, and Attention Disorders

Challenges for those with ASD/IDDs	Improvements Suggested in Interviews
• Difficulty understanding or remembering directions	• Installation of wayfinding signage and elements that employ universally understood graphics and a thoughtful use of color.
• Differences among those with ASD and IDDs in how information is most easily interpreted, including forms of visual, audible, and tactile communication	• Consideration of digital wayfinding signage that communicates information visually, auditorily, and tactilely.

Symptoms: Speech & Language Delays, Non-Verbal Communication, Learning Disorders, Difficulty Navigating Social Situations

Challenges for those with ASD/IDDs	Improvements Suggested in Interviews
• Challenges with reading signs • Difficulty asking strangers for help, such as to ask directions	• Installation of wayfinding signage and elements that employ universally understood graphics and a thoughtful use of color

Bicycling

Compared to walking, bicycling among those with ASD and IDDs is less common. According to the survey conducted for the Rutgers *Detour to the Right Place* study, only 5.8% of respondents with ASD reported bicycling for transportation in the previous three months.[37] In interviews, participants with ASD and IDDs indicated wanting to bicycle more, but feeling hesitant to bicycle alongside drivers who they do not trust to drive safely. Interviews found that some with ASD who previously bicycled stopped after experiences with driver intimidation. In addition, some with ASD avoid bicycling due to fear that they will not be able to remember where and how to ride safely. Others with ASD and IDDs may avoid bicycling due to challenges with physical coordinaton and motor control. Infrastructure-related barriers to bicycling raised in interviews include a lack of access to secure bicycle storage and a lack of bicycle facilities like protected bike lanes and bicycle-specific paths that are separate from pedestrian walkways.

Figure 27. Given the reported hesitancy around bicycling, those with ASD and IDDs would benefit from more protected and separated bicycling infrastructure. (NJDOT Bicycle and Pedestrian Resource Center)

Given the hesitancy around bicycling, those with ASD and IDDs would benefit from more protected and separated bicycling infrastructure and secure parking. Many with ASD prefer to ride tricycles, so bicycle infrastructure should be designed to accommodate a wider range of device types. Additionally, since communication is important for individuals with ASD and IDDs, bicycle lanes and infrastructure should clearly demonstrate where and how bicyclists should be riding. As noted in interviews, Individualized Education Plans (IEPs) for youth with ASD and IDDs can be designed to incorporate walking and bicycling education. Providing active transportation training from a young age, especially around bicycle skills, could help empower those with ASD and IDDs and alleviate the hesitancy some may feel regarding bicycling in their community.

Symptoms: Cognitive Impairment, Limited Adaptive Behaviors, and Attention Disorders

Challenges for those with ASD/IDDs	Improvements Suggested in Interviews
• Difficulty understanding or remembering directions	• Clear signage indicating how to use bicycle infrastructure and where bicyclists should be riding

Symptoms: Tolerating Sensory Input

Challenges for those with ASD/IDDs	Improvements Suggested in Interviews
• Reluctance to ride a bicycle in close proximity to loud, fast-moving motor vehicle traffic • Lack of trust that those in motor vehicles will drive safely around bicyclists • Fear of driver intimidation while bicycling	• Installation of more protected bicycle lanes and separated bicycle paths that are wide enough to accommodate a variety of device types, such as tricycles • Installation of secure and accessible bicycle parking

Symptoms: Speech & Language Delays, Non-Verbal Communication, Learning Disorders, Difficulty Navigating Social Situations	
Challenges for those with ASD/IDDs	**Improvements Suggested in Interviews**
• Lack of bicycle riding and safety education during childhood, resulting in hesitancy around bicycling later in life	• Incorporation of bicycling skills training as part Individualized Education Plans to provide active transportation training from a young age

Other Concerns	
Challenges for those with ASD/IDDs	**Improvements Suggested in Interviews**
• Lack of accessible bicycle facilities for those with cognitive or physical disabilities associated with ASD and IDDs	• Installation of more protected bicycle lanes and separated bicycle paths that are wide enough to accommodate a variety of device types, such as tricycles • Installation of secure and accessible bicycle parking

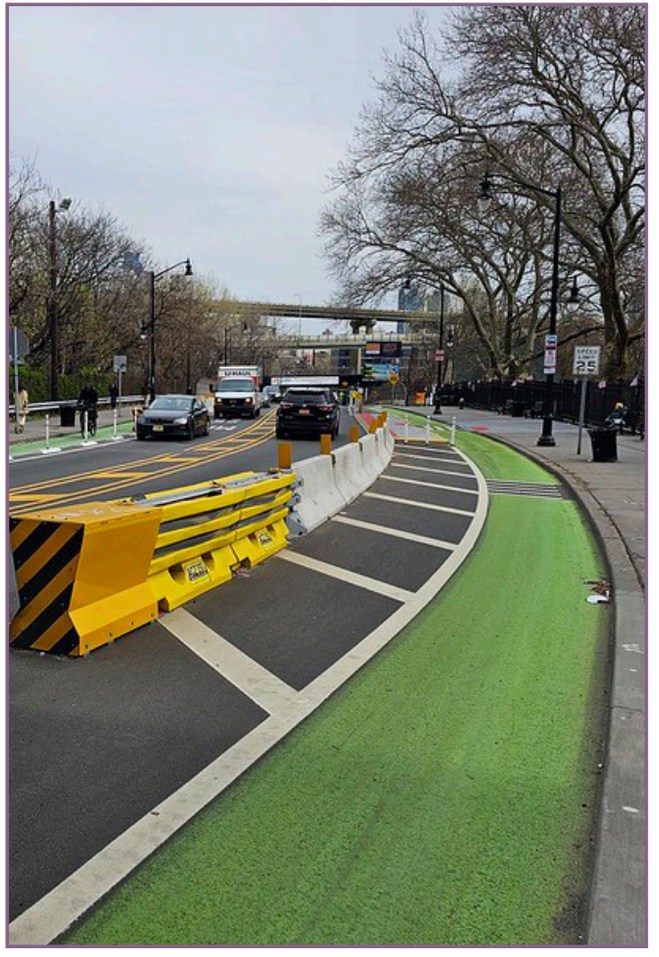

Figure 28. Neurodivergent individuals may benefit from the installation of more protected bicycle lanes and separated bicycle paths that are wide enough to accommodate a variety of device types, such as tricycles. (NJDOT Bicycle and Pedestrian Resource Center)

Transit and Travel Training

Despite the apparent widespread support for transit, implementation of transit system accessibility features, and the demonstrated value of travel training (although not widely available), most neurodivergent adults in New Jersey have never engaged with public transit. When asked about their reservations regarding transit use, neurodivergent survey respondents cited concerns such as infrequent service, long distances to transit stops or stations, high costs, public stigma, and safety issues.[38] Notably, several of these concerns **could be alleviated through enhanced walkability features**, given the direct correlation between the utility of public transit and a pedestrian's ease of access to it.

Interviewees also raised transit-related concerns adjacent to Complete Streets. These included the need for more amenities such as universal shelters, clear wayfinding signage and navigational aids, and informational guides. Transit schedules, fare structures, and payment systems should also be easy to understand and posted at stations and stops. In one interview, dedicated bus lanes were recommended to reduce headways and make schedules more predictable. Interview participants also identified transit staff-related recommendations, including training to promote greater ASD and IDD awareness among transit employees.

Figure 29. Travel training for individuals with autism and intellectual and developmental disabilities. (New Jersey Travel Independence Program @ Rutgers)

For neurodivergent individuals seeking to use transit services, **travel training programs** can play an important role in enhancing clients' abilities to independently navigate public transportation.[39] Strong interest in receiving travel training among New Jersey residents with ASD and IDDs was documented in the *Detour to the Right Place* study. However, only 32% percent of study survey respondents had received such training. Travel training programs, such as the New Jersey Travel Independence Program at Rutgers University (NJTIP @ Rutgers), interviewed for this study, focus on teaching persons with diverse disabilities, including ASD and IDDs, how to safely and independently use public transportation statewide, including accessible bus, rail, and light rail. NJTIP introduces and teaches individuals and small groups the necessary skills that build familiarity on how to safely travel by public transit. Furthermore, participants are empowered and gain confidence by learning how to safely navigate the built environment to access transit and destinations that can include employment, continuing education, medical, and daily living trips. Although extremely beneficial to persons with ASD and IDDs, travel training is not a required service by law for persons with disabilities and thus, most New Jerseyans with disabilities do not receive travel training through their educational programming.

In addition to teaching skills related to transit use, travel training programs can provide opportunities to teach individuals with ASD and IDDs about navigating reconstructed streets and intersections on foot. Many neurodivergent individuals prefer routine and can therefore experience challenges when navigating streets and sidewalks that are under construction or have been recently reconstructed. Travel training programs can be expanded in scope to assist trainees by providing tours of redesigned roads and intersections.

It should also be noted that travel training programs such as NJTIP @ Rutgers offer a potential resource to help document built environmental barriers experienced by persons with disabilities on a daily basis. For example, when travel trainers experience challenges for their clients during trips using NJ TRANSIT facilities, they report conditions and obstructions directly to NJ TRANSIT. However, there is no similar reporting mechanism for accessibility issues in the built environment outside of transit facilities. Establishment of a reporting mechanism to NJDOT, county, and local points of contact who can receive and review documented barriers as reported by New Jersey travel instructors could serve as a means to identify and prioritize improvements to the transportation environment. In addition, points of contact could meet with graduates of travel training instruction to discuss challenges and needs.

Improvements suggested in interviews include, but are not limited to:

- Include wider and financial support for travel training programs.
- Expand travel training programs to include guided tours of reconstructed streets and intersections.
- Implement a system for reporting infrastructure challenges and barriers for people with disabilities.

The Connection Between Land Use and Transportation

The prevalence of cars in the American transportation landscape can be largely attributed to historical land use decisions that have shaped development patterns nationwide. Zoning ordinances that limit **density and mixed-use developments** have systemically segregated land uses, ensuring that necessary destinations – like pharmacies and grocery stores – remain distinct from residential neighborhoods. The resulting distance between origins and destinations acts as a deterrent to active transportation modes, like walking and bicycling.

Allowing the use of a**ccessible dwelling units (ADUs)**[40] could broaden the range of housing options available to neurodivergent individuals who desire greater independence while staying close to crucial support networks like family and friends. Accessible dwelling units are independent residential dwelling units located on the same lot as a stand-alone (i.e., detached) single-family home.

NJ Bill S-147 (Complete Streets for people with ASD and IDD) requires that NJDOT encourage regional and local entities that apply for funding through the local aid program to adopt a Complete Streets policy that complies with the new legislation. Extra consideration on applications to the Division of Local Aid and Economic Development could be added to grant scoring for municipalities that update Complete Streets policies to include addressing the needs of people with ASD/IDDs.

In addition, NJDOT's Complete and Green Streets model policy language should be updated to reflect NJ Bill S-147 (Complete Streets for people with ASD and IDD). The Complete and Green Streets Model Policy and Guide includes checklists from project conception to implementation. Many municipalities adopt these checklists and require developers to complete and submit them as part of the planning board approval process. Thus, Complete Streets checklists provide an opportunity to address housing and commercial development land use and their connection to local streets and roads.

Improvements suggested in interviews include, but are not limited to:

- Mixed-use zoning
- Higher allowable residential density
- Accommodating accessible dwelling units
- Adoption of the language in NJDOT's Complete and Green Streets model policy and adding to scoring on Local Aid grant applications

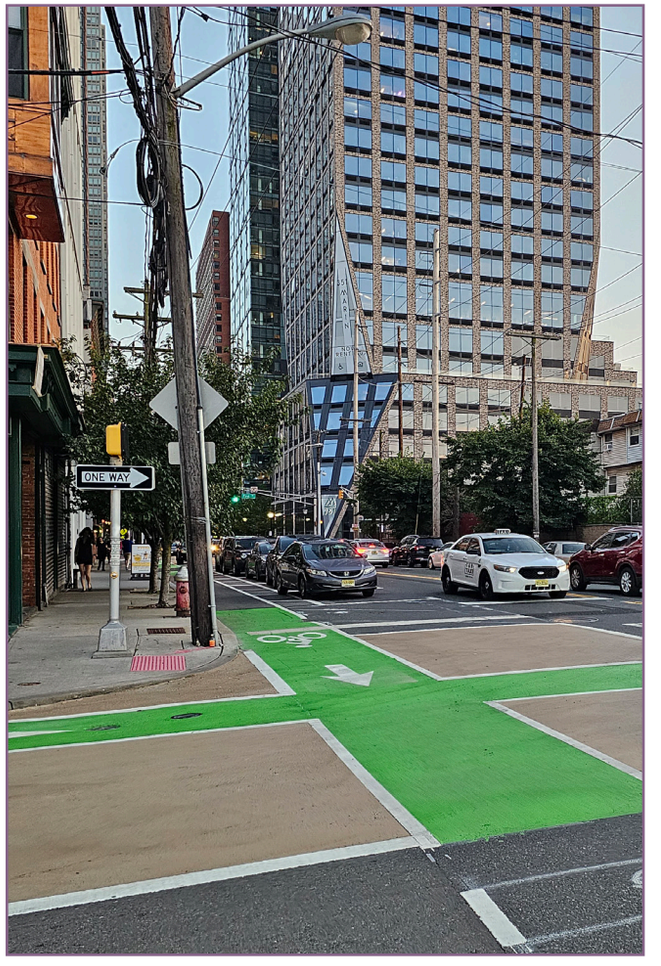

Figure 30. Higher density, mixed-use zoning supports more walkable communities that in turn promote independent travel for individuals with ASD and IDDs. (NJDOT Bicycle and Pedestrian Resource Center)

Consistency is Key

Equally important to the details of each design treatment is the consistent universal design deployed state-wide. This approach ensures that a neurodivergent pedestrian who has learned, for instance, to navigate a crosswalk in one part of New Jersey can confidently and independently apply those skills across all regions of the state. Moreover, the uniformity of these universal design elements extends benefits to the general public for similar reasons.

Figure 31. Considerations for universal design should emphasize consistency among infrastructure treatments to ensure pedestrians can generalize skills across regions. (NJDOT Bicycle and Pedestrian Resource Center)

Endnotes

1 Throughout the remainder of this document, the following terms will be used interchangeably "people with ASD and/or IDDs, neurodiverse/neurodivergent people, and members of the neurodivergent community."

2 Devajyoti, Feeley, & Lubin, 2016.

3 https://adata.org/factsheet/ada-definitions

4 https://www.ada.gov/law-and-regs/ada/

5 https://highways.dot.gov/civil-rights/programs/ada/ada-transition-plan-and-inventory-map

6 https://www.access-board.gov/prowag/application.html

7 https://mutcd.fhwa.dot.gov/

8 https://www.cdc.gov/ncbddd/autism/facts.html

9 For more information on ASD levels, see "Level 1/2/3 ASD" in the Glossary of Terms in the appendices of this document.

10 https://autismnj.org/understanding-autism/prevalence-rates/

11 Devajyoti, Feeley, & Lubin, 2016

12 https://www.mountsinai.org/health-library/diseases-conditions/asperger-syndrome

13 https://www.nichd.nih.gov/health/topics/idds/conditioninfo

14 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5834391/

15 https://www.cdc.gov/ncbddd/cp/data.html

16 https://www.cdc.gov/nchs/products/databriefs/db473.htm#:~:text=2019%20to%202021.-,During%202019%E2%80%932021%2C%20the%20prevalence%20of%20any%20diagnosed%20developmental%20disability,and%201.65%25%20in%202021).

17 Jones, S., Mackett, R., & Castillo, J. (2023). Invisible disabilities: seeing the unseen. TR News Issue 346: Addressing Transportation and Accessibility for All. Retrieved September 2023.

18 https://www.nichd.nih.gov/health/topics/fragilex/conditioninfo/commonsymptoms

19 https://www.ncbi.nlm.nih.gov/books/NBK547654/

20 https://www.aaidd.org/intellectual-disability/definition/adaptive-behavior#:~:text=Adaptive%20behavior%20is%20a%20different,learn%20a%20set%20of%20skills

21 Devajyoti, Feeley, & Lubin, 2016

22 https://nhts.ornl.gov/od/

23 Devajyoti, Feeley, & Lubin, 2016

24 Curry AE, Metzger KB, Carey ME, Sartin EB, Huang P, Yerys BE. Comparison of Motor Vehicle Crashes, Traffic Violations, and License Suspensions Between Autistic and Non-Autistic Adolescent and Young Adult Drivers. J Am Acad Child Adolesc Psychiatry. 2021 Jul;60(7):913-923. doi: 10.1016/j.jaac.2021.01.001. Epub 2021 Jan 13. PMID: 33453361; PMCID: PMC8918049.

25 https://www.co.hunterdon.nj.us/1605/Blue-Envelope-Program; https://www.rosenet.org/1453/Blue-Envelope-Program

26 Devajyoti, Feeley, & Lubin, 2016

27 Rosli NS, Hamsa AAK. A THEORETICAL REVIEW IN EVALUATING THE IMPACT OF TRAFFIC-CALMING MEASURES ON THE RESIDENTIAL LIVING ENVIRONMENT.

28 Devajyoti, Feeley, & Lubin, 2016

29 Rosenbloom, T., Haviv, M., Peleg, A., Nemrodov, D., 2008. The effectiveness of roadsafety crossing guards: Knowledge and behavioral intentions. Safety Science 46, 14501458.

30 N.J. Stat. § 39:4-36

31 https://toolkit.irap.org/safer-road-treatments/intersections-turn-lanes-signalised/#:~:text=Signalised%20intersections%20with%20fully%20controlled,vehicles%20and%20oncoming%20through%20traffic.

32 https://www.access-board.gov/prowag/preamble.html

33 https://www.access-board.gov/prowag/technical.html

34 https://highways.dot.gov/safety/proven-safety-countermeasures/rectangular-rapid-flashing-beacons-rrfb

35 https://www.access-board.gov/prowag/technical.html

36 https://highways.dot.gov/safety/proven-safety-countermeasures/roundabouts

37 Devajyoti, Feeley, & Lubin, 2016

38 Devajyoti, Feeley, & Lubin, 2016

39 Pfeiffer, B., Sell, A., & Bevans, K. B. (2020). Initial Evaluation of a Public Transportation Training Program for Individuals with Intellectual and Developmental Disabilities: Short Report. Journal of Transport & Health, 16. https://doi.org/10.1016/j.jth.2019.100813

40 More information on ADUs can be found in the Glossary section of this document

APPENDICES

Glossary of Terms

Accessible Design – Accessible design is a design process in which the needs of people with disabilities (including auditory, cognitive, physical, and visual disabilities) are specifically considered. Accessibility sometimes refers to the characteristic that products, services, and facilities can be independently used by people with a variety of disabilities. Accessibility has a narrower scope than inclusive or universal design in that it is focused on specific accommodations.
Source: *Nielsen Norman Group; University of Washington*

Accessory Dwelling Unit (ADU) – An accessory dwelling unit (ADU) is a smaller, independent residential dwelling unit located on the same lot as a stand-alone (i.e., detached) single-family home. ADUs go by many different names throughout the U.S., including accessory apartments, secondary suites, and granny flats. ADUs can be converted portions of existing homes (i.e., internal ADUs), additions to new or existing homes (i.e., attached ADUs), or new stand-alone accessory structures or converted portions of existing stand-alone accessory structures (i.e., detached ADUs).
Source: *planning.org*

Active Transportation - Active transportation is human-powered mobility, such as bicycling, walking, or rolling. Active transportation directly replaces motor vehicle miles traveled, so these modes are effective at conserving fuel, reducing vehicle emissions, bridging the first and last mile gap, and improving individual and public health. Bicycles, electric bikes, wheelchairs, scooters, and even walking are all considered active transportation.
Source: *US Department of Energy*

Autism Spectrum Disorder (ASD) – Autism spectrum disorder (ASD) is a neurological and developmental disorder affecting how people interact, communicate, learn, and behave. People with ASD often have problems with social interaction, restricted or repetitive behaviors or interests, and process sensory information differently than their neurotypical peers. Autism is known as a "spectrum" disorder because there is wide variation in the type and severity of symptoms people experience.
Source: *Centers for Disease Control and Prevention; National Institute of Mental Health*

Augmentative/Alternative Communication Devices (AACs) – AACs are devices (commonly tablets) that help someone with speech or language impairments communicate.
Source: *Lingraphica.com*

Complete Streets – Complete Streets is an approach to planning, designing, and building streets to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. Complete Streets also emphasizes the needs of those who have experienced systemic underinvestment, or those whose needs have not been met through traditional transportation planning and design.
Source: *NJDOT Bicycle and Pedestrian Resource Center*

Human-Centered Design – Human-centered design is an approach to problem-solving that puts people at the heart of the process. The human-centered design process begins with empathy for the people being designed for. The process generates a wide variety of ideas, translates some of these ideas into prototypes, and shares these prototypes with the people being designed to gather feedback in an iterative process.
Source: *vic.gov.au*

Identity First Language – Identity first language puts the condition before the person and describes a person as a group member. Ex. An autistic person. For some people who prefer identity-first language, the choice is about empowerment.
Source: *Northeastern.edu*

Inclusive Design – Inclusive design describes methodologies to create products or environments that understand and enable people of all backgrounds and abilities. Inclusive design may address accessibility, age, culture, economic situation, education, gender, geographic location, language, and race. The focus is on fulfilling as many user needs as possible, not just as many users as possible. Inclusive design often involves as many people as possible in the design process to promote personal well-being, social cohesion, and enjoyment for all. The term "inclusive design" is similar to and sometimes used interchangeably with the term "universal design." (see below)
Source: *Nielsen Norman Group; UK Commission for Architecture and Built Environment*

Intellectual and Developmental Disabilities (IDDs) – IDDs are differences usually present at birth and uniquely affect the trajectory of the individual's physical, intellectual, and/or emotional development. The term is composed of two types of geographic location, language, and race. The focus is on fulfilling as many user needs as possible, not just as many users as possible. Inclusive design often involves as many people as possible in the design process to promote personal well-being, social cohesion, and enjoyment for all. The term "inclusive design" is similar to and sometimes used interchangeably with the term "universal design." (see below)
Source: *National Institute of Child Health and Human Development*

Level 1/2/3 ASD – Level 1, 2, and 3 ASD are terms that refer to the level of independence a person with autism has. For example, a person with Level 1 ASD may be capable of independently holding conversations with peers, performing self-care tasks, and self-regulating their response to sensory information. In contrast, a person with Level 3 autism may have significant language delays and require significant support to complete daily tasks.

Formerly referred to as "low & high functioning" autism, a growing dislike for these terms in the neurodivergent community has led to them being phased out and replaced with "levels" of autism.

- Level 1 ASD – Formerly known as "high functioning," is the mildest form of ASD and requires minimal support.
- Level 2 ASD – This level is characteristic of moderate symptoms and may require substantial support.
- Level 3 ASD – Formerly known as "low functioning," is the most severe level of symptoms and requires significant support.

Source: *Verywellhealth.com*

Micromobility – The Federal Highway Administration broadly defines micromobility as any small, low-speed, human- or electric-powered transportation device, including bicycles, scooters, electric-assist bicycles, electric scooters (e-scooters), and other small, lightweight, wheeled conveyances.
Source: *US DOT*

Mobility Impairment – A mobility impairment is a disability that affects movement ranging from gross motor skills, such as walking, to fine motor movement, involving manipulation of objects by hand.
Source: *Washington.edu*

Neurodiverse/Cognitively Diverse – Neurodiversity describes how people experience and interact with the world around them in many different ways; there is no one "right" way of thinking, learning, and behaving, and differences are not viewed as deficits. The word neurodiversity refers to the diversity of all people, but it is often used in the context of autism spectrum disorder (ASD), as well as other neurological or developmental conditions such as ADHD or learning disabilities. "Cognitively Divergent" is a similar term and may be used similarly to neurodiverse.
Source: *Harvard Medical School*

Neurotypical - The term neurotypical may be used to describe individuals whose brains develop and function in ways that are considered usual or expected by society, excluding people with developmental disorders such as ASD, Down Syndrome, and others. Perceived traits of a neurotypical personality may include strong social and communication skills, proficiency in navigating socially complex situations, and the ability to participate in loud, crowded, or visually overwhelming settings.
Source: *Verywellhealth.com*

Person First Language – Person first language puts the person before the disability and describes what a person has or struggles with, not who a person is. Ex. A person with autism.
Source: *Office of Disability Rights*

Sensory – A common symptom of ASD and IDDs are differences in the perception of sensory information: sight, hearing, taste, touch, and smell. Individuals with these disorders may experience hyper or hyposensitivity to a wide range of stimuli. Many individuals with ASD experience hypersensitivity to bright lights, certain smells, tastes, and textures. Noisy, crowded areas may also be overwhelming to people with ASD, which will cause them to avoid certain places and activities.
Source: *National Library of Medicine*

The Cliff – The "cliff" is a term for the point in the lives of people with ASD or IDDs when they reach adulthood (22nd birthday) and are no longer eligible for federal support services encompassed under the Individuals with Disabilities Education Act (IDEA), such as those provided by mental health clinicians, speech therapists, social workers, adaptive equipment, and subsidized transportation services. This sudden loss of services contributes to a situation where young adults with ASD or IDDs have difficulty accessing employment and job training and may even regress in some skill sets.
Source: *Drexel University*

Universal Design – Universal Design is the design and composition of an environment so that it can be accessed, understood, and used to the greatest extent possible by all people regardless of their age, size, ability, or disability. An environment (or any building, product, or service in that environment) should be designed to meet the needs of all people who wish to use it.
Source: *The Center for Excellence in Universal Design*

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